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A PRELIMINARY FOREST HABITAT CLASSIFICATION FOR THE LINCOLN NATIONAL FOREST, NEW MEXICO

A PRELIMINARY FOREST HABITAT CLASSIFICATION FOR THE LINCOLN NATIONAL FOREST, NEW MEXICO

A Final Report Prepared for
the Rocky Mountain Forest and Range
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by

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ABSTRACT

Vegetation data were collected from the Lincoln National Forest, New Mexico to construct a potential natural vegetation (PNV) forest habitat classification. Seventeen habitat types and phases were developed from this study. Seven more types were found by Moir and Ludwig (1979), and are discussed as they apply to this study. The total of twenty-four habitat types and phases represent six tree species series. These series include: the Abies lasiocarpa, the Picea engelmannii, the Picea pungens, the Abies concolor, the Pseudotsuga menziesii, and the Pinus ponderosa.

Each habitat type within the series is described as to vegetative composition, topographical occurrence, soils, ecotones and adjacent habitats, and discussion of overall qualities.

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INTRODUCTION

This study is a vegetation classification of forest habitat types for the Lincoln National Forest (LNF). This work applies to the ponderosa pine forest upwards in elevation to include the spruce-fir forest type. This classification is based on a potential natural vegetation concept (PNV). The forest habitat types discussed in this classification are thought to represent the forest in an old, nondisturbed condition or climax state. Forests in a pre-climax state are described in successional studies. This study is preliminary to a successional study and consequent mapping.

A classification for the Southwest is important from a management standpoint. It is crucial to understand the ecological aspects of the southwestern forests in order to make sound managerial decisions. Classifying provides an organizational step to predicting ecological responses to forest treatments.

Forest classification based on PNV is relatively new to the Southwest. Previous classification work on the Lincoln National Forest has investigated the mixed conifer and spruce-fir types of the forest. Moir and Ludwig (1979) have recognized nine habitat types of the mixed conifer and spruce-fir types on the LNF. Dye and Moir (1977) describe the compositional elements of the spruce-fir forest near Sierra Blanca Peak on the LNF. Their study shows the possible similarities between the southern Rocky Mountain spruce-fir and the more northern spruce-fir types. Hanks and Dick-Peddie (1974) studied successional trends in the White Mountains, a prominent range of mountains on the LNF. Their study identified the various stages of successional progress after disturbance to the forest. The importance of this kind of study is to elucidate the vegetational events leading up to the older sites. Hanks (1966) presents a more basic paper of a similar nature.

Along with the present study other investigations were and are being

conducted throughout the Southwest region. Fitzhugh and Hanks (in press) have completed a classification for the ponderosa pine of the northern Arizona region. Currently being completed are studies from the Cibola, Gila, Santa Fe and Carson National Forests in New Mexico. When completed, these studies will emphasize differences and similarities between geographical regions as to habitat types. Studies of this nature in the Southwest are comparable to those completed in the more northern regions of the western United States (Daubenmire 1952, 1968; Pfister, et al 1977).

The purpose of forest habitat classification involves four objectives. This study is designed to classify the forest habitat types, based on PNV, of the Lincoln National Forest. Previous classification studies of the LNF will be tested (Moir and Ludwig 1979). From the classification system developed for the forest, clarification of some successional direction can be made. Finally, management applications can be proposed from the major conclusions.

AREA OF STUDY

The Lincoln National Forest is located in south-central New Mexico. The LNF lies adjacent to the thirty-third latitudinal parallel and between the 105th and 106th longitudinal line. This position situates the LNF as one of the southernmost extensive stands of timber in the western United States. For geographical reference, the area of study lies east of the Rio Grande, west of the Texas High Plains, south of the contiguous Rocky Mountains, and north of the Chihuahuan Desert (figure 1). The Lincoln National Forest is distinct from the Colorado Plateau, and lies in an area which is heavily faulted.

As with many southwestern mountains the mountains of the LNF are surrounded by desert or desert grassland. These mountainous areas can be characterized as biogeographical islands. This idea of isolation has special importance in comparing vegetation characteristics between forests of the southwest (Shreve 1922). Isolation has led to speciation and endemic habitat types in the southwestern United States.

Geography

The Lincoln National Forest is itself divided into fragmented mountain ranges. This situation creates biological islands within the LNF itself. However, the differences between these fragmented mountains and areas outside the LNF should be greater than differences within the Lincoln National Forest. This establishes a regional identity for the Lincoln National Forest insofar as vegetation habitats are concerned.

The Lincoln National Forest is divided into five areas (Figure 2). The Sacramento Mountains are the southern extent of this study. North of the Sacramentos lie the White Mountains, which include Sierra Blanca Peak. North and east of the White Mountains is a series of smaller mountains, the Carrizo

FIGURE 1: Location of the Lincoln National Forest in the State of New Mexico

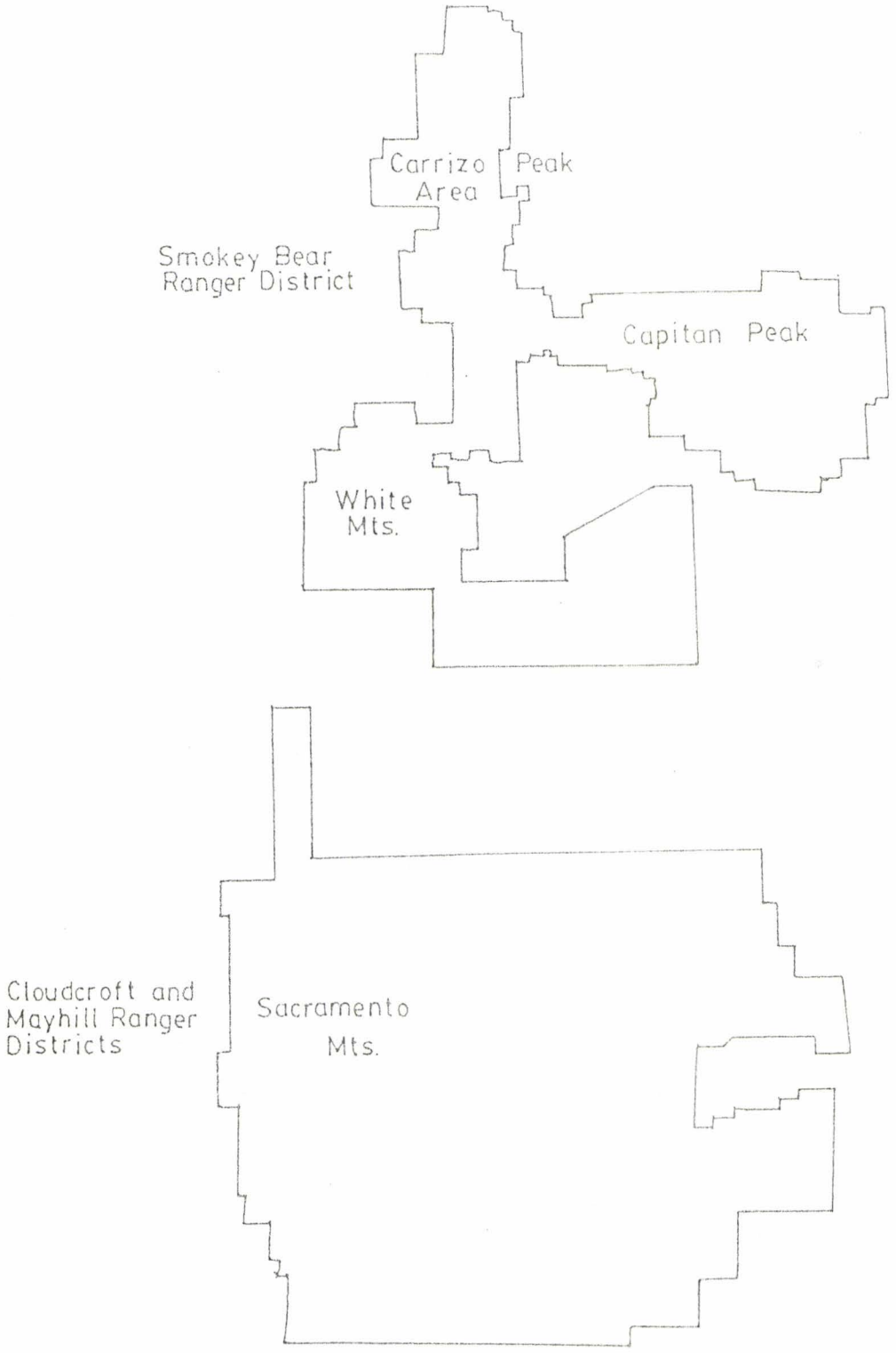

FIGURE 2: Geographical Divisions of the Lincoln National Forest

Peak area (includes the Jicarrillo and Patos Mountains) and the Capitan Peak area. The Guadalupe Mountains to the south were not included in this study. It was felt that the Guadalupe Mountains did not contain enough timbered sites to meet the objectives of this study.

Geology

The mountains of the Lincoln National Forest have a diverse geological background. The mountains are a result of numerous uplifts and extrusive action, resulting in steep elevational relief.

The Sacramento Mountains, in the southern half of the forest, are the result of a massive uplift. This is evidenced by a steep escarpment on the western flank. The primary parent material is from the San Andres Limestone formation. In some areas the underlying Yeso Siltstone is a prominent feature (Weber 1964, Hunt 1977).

To the north are the White Mountains, Carrizo Peak area, and the Capitan Mountains. This area is characterized by more extrusive volcanic activity. The parent materials are more diverse in this region. The Sierra Blanca and Nogal Peak area is dominated by andesitic parent material. Several dikes and volcanic plugs can be seen in the White Mountains near Sierra Blanca Peak. The Capitan Peak system is a large, linear, east to west, extrusive mass. The parent material of the Capitan Peak area appears similar to that of the White Mountains, andesite; however, the rock has a much redder hue to it. This parent material was called "alaskite" by the soil scientist on the Lincoln National Forest*. It appears that the Carrizo Peak area is of a similar geologic nature.

Topography

The extrusions and uplifts have shaped the topographical qualities of the

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*Cliff Landers, soil scientist, Lincoln National Forest, 1979: personal communication.

Lincoln National Forest and have a resultant effect on vegetation occurrence. For both the Sacramento Mountains and the White Mountains, the uplifts have resulted in steep westerly faces. In the Sacramentos the opposite east slope has a more gentle overall slope to it. The east side of the White Mountains is quite steep as it is a result of volcanic extrusions.

This steep west slope and gentle east slope of the Sacramento Mountains result in a narrowing of the elevational "bands" on the west slope and a widening of the bands on the gentle east slope. This point is crucial in terms of the effects it has on the structure of the vegetation which occupies these elevational bands. The vegetation shows a sharp transition between the more xeric pinyon-juniper community and the more mesic mixed conifer. The ponderosa pine community is nearly absent and is at best restricted in this area. This effect is a result of the northeasterly and near easterly advance of summer storms rising off the Tularosa Basin to the west. When these storms move into the mountains they create a sharp distinction between areas of higher rainfall and those of lower precipitation, hence the sharp delineation of the vegetation.

The northern half of the forest is characterized by more volcanic activity, hence the easterly slopes may be as steep as the west slopes. However, on the west slope of both the White Mountains and Carrizo Peak this sharp vegetation zone appears once again. The Capitan Mountains illustrate great relief on both the north and south slopes. These slopes have long bajada systems at lower elevations. The east slope of the Capitan Peak is fairly unique, being quite steep and highly dissected.

Water on the Lincoln National Forest is quite variable. In the Sacramento Mountains there are many perennial streams. In some areas the valleys through which they flow are nothing more than wet meadows. Agriculture in some of the valleys has led to the draining of the meadows. The White Mountains to the north also have several perennial streams which are utilized quite

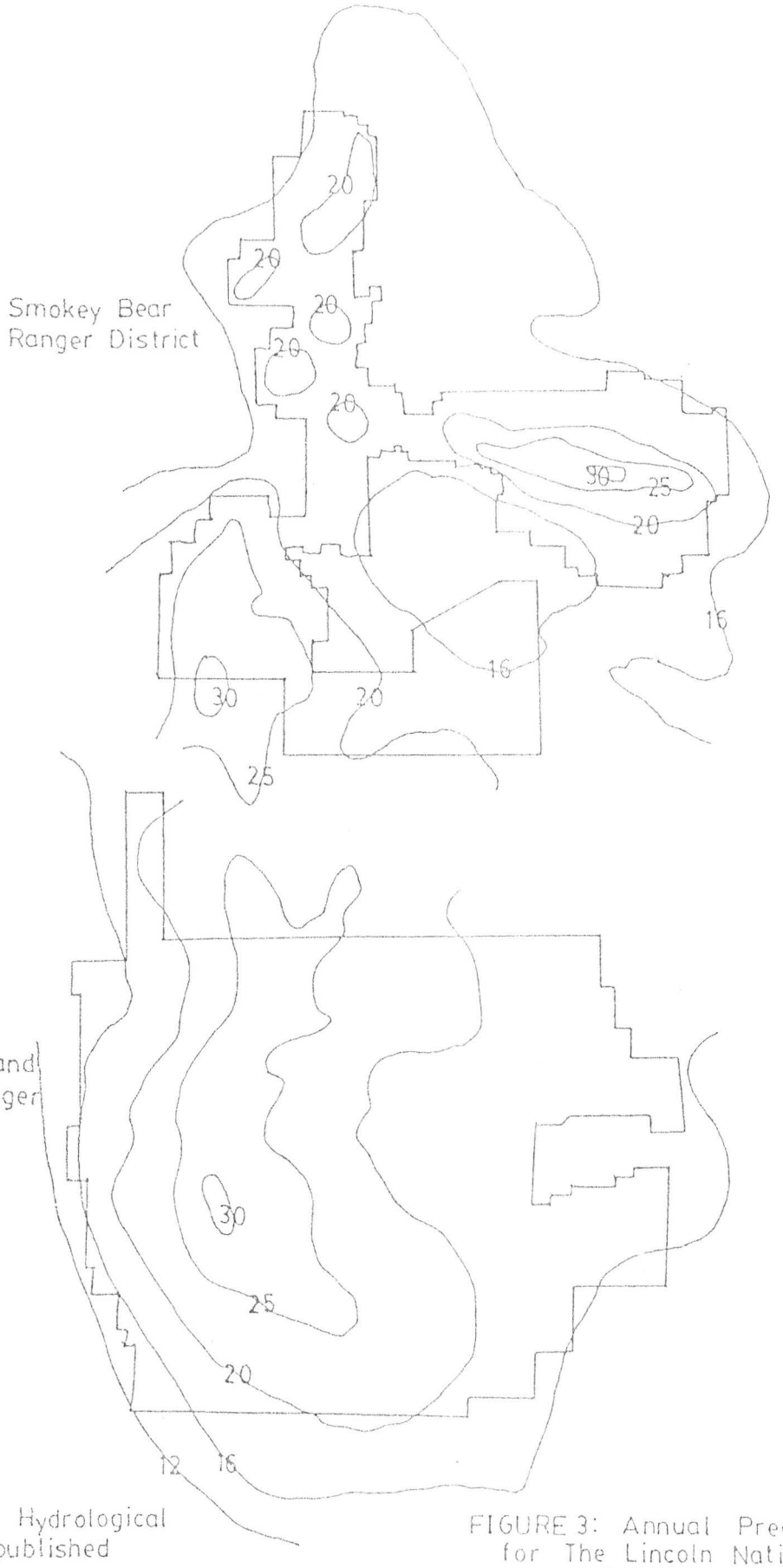
heavily for their recreational benefits. Both Corrizo Peak and Capitan Peak have no perennial streams. In these areas are found many springs and ephemeral streams which provide the habitat for riparian vegetation.

One of the more interesting geotopographical features on the Lincoln National Forest is the presence of rock glaciers on the Capitan Peak area. From the ground the slopes of rock look like ordinary scree slopes, but from the air the rock can be observed in its slow creep down the mountain. These areas have sparse vegetation cover, but do have an effect, mostly water related, on the toe slope below them.

Climate

Climate is undoubtedly a major element of the integrated environmental factors which affect the occurrence of plant habitat types. Throughout the Southwest there are varying patterns of climate that occur in the different geographical regions. As one moves eastward in the Southwest, summer precipitation becomes more prominent on the annual rainfall pattern (Forest Service hydrological report, unpublished). Roughly 60% of the annual precipitation falls in the summer months, with 40% occurring in the winter. In some areas of the Lincoln the distribution is 70% to 30%, summer to winter respectively. July begins the summer wet period which ends in September. The fall dry period occurs in October and November. The Winter wet period begins in December and ends in mid April. From mid April through June is the spring dry period. Annual precipitation for the timbered areas for the wet periods is between 20 and 30 inches. Figure 3 shows this annual pattern of precipitation for various localities on the forest (Forest Service hydrological report, unpublished).

The summer wet period will drop from between 12 and 18 inches of precipitation over the timbered areas. The precipitation is usually from large convective storms which collect near the mountains. The major source of



Source: F.S. Hydrological Report, unpublished

FIGURE 3: Annual Precipitation for The Lincoln National Forest (in inches)

moisture for these storms is an influx of wet air from the Gulf of Mexico (Forest Service hydrological report, unpublished). These storms are important elements in providing moisture for the growing season, especially for the herbaceous plants. It is not altogether clear what effect the heavy moisture during the summer has on timbered species. Some studies point to winter precipitation as being the dominant factor in the growth and establishment of timbered species (Fritts 1974).

In the winter wet period precipitation falls mostly as snow. The source of the moisture in this period can come from continental polar air and maritime polar air masses (Forest Service hydrological report, unpublished). This results in frontal systems from the northwest and west. In timbered areas, 8 to 12 inches of precipitation will fall during this wet period. Moisture from this wet period is stored moisture whcih saturates the soils during the spring thaw.

The dry periods of the Lincoln National Forest are not droughts as they are quite predictable. Predictability on the average, however, does not mean every year. During the year of this study, the Lincoln National Forest experienced a very wet spring, which is normally a dry period.

Historical Events

Interpretations of past events are critical to understanding current composition of vegetation on the Lincoln National Forest. Past events can be classified into two general groups: those which are natural, and those which are a result of man. This distinction is important considering the amount of time the ecosystem has had to adapt to the disturbances.

Perhaps the most important historical natural environmental factor was fire. Fire scars indicate that fire was once an active part of the environment. Studies show that pine forests in the Southwest burned on the average every

7 or 8 years (Weaver 1951). Biswell (1973) estimates more frequent fires, once every 2 or 3 years, occurring in ponderosa pine forests. This time span was short enough for there to be adaptive pressures on the ecosystem. The kind of fires, given the time span, were not very intensive. Fuel did not build up enough for fires of a catastrophic nature. This low intensity and short frequency had an adaptive effect on the plants that make up the ecosystem.

Ponderosa pine (Pinus ponderosa*) was one of the fire-adapted plants. A fire could burn through a stand of old ponderosa pine, burning the light fuels and grassy understory, without damaging the overstory to any great extent. The primary effect was to maintain stands of ponderosa pine in a seral condition throughout much of its range. Since this seral condition was the norm rather than the exception we refer to it as a disclimax condition.

This fire adaptation of ponderosa pine had a profound effect in that region of the forest which, left undisturbed, would reach climax condition in the less fire resistant mixed conifer species. Ponderosa pine could maintain itself in spite of the fire, while the mixed conifer species could not. This led to relatively pure stands of ponderosa pine, being maintained by the reproduction which could survive the fires.

A similar situation existed in the lower elevational ponderosa pine to pinyon-juniper transition zone. Fire also excluded the less resistant junipers (Juniperus spp.) and pinyon pine (Pinus edulis). Again, pure stands of ponderosa pine were maintained on these sites. Essentially this fire adaptation of ponderosa pine enabled it to exist in relatively pure stands in a much wider elevational zone than if there were no fires.

Fire exclusion, as a result of European settlement and active forest management, resulted in invasion by those species which are less fire adapted.

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*Reference to Lehr 1978

Today the forest in many areas is in an advanced successional state. This consists of a ponderosa pine mature overstory with the young and intermediate age classes being made up of mixed conifer species, such as Douglas fir (Pseudotsuga menziesii), southwestern white pine (Pinus strobiformis), and white fir (Abies concolor). The lower elevational zones consist of juniper (primarily Juniperus deppeana) and pinyon pine. This has resulted in a narrowing of the ponderosa pine zone to those areas which are climatic climax to ponderosa pine. This has led to an expression of the climatic climax boundaries of all species independent of the effects of fire. Further discussions of the effects of fire on the southwestern forests can be found in Weaver (1951), Cooper (1960), and in Biswell (1973).

This exclusion of the high frequency-low intensity fires has led to an alteration of the fire pattern that occurs on the Lincoln National Forest today. Buildup of high fuel levels has occurred without burning to reduce them. Seedlings of all timber species have not been thinned out by fire, resulting in very dense fuel ladders. Both of these changes have led to the susceptibility of the forest to catastrophic fires, which are devastating to the ecosystem. Just as there are plants adapted to low intensity fire, there are plants adapted to catastrophic fires. Gambel oak (Quercus gambelii) is the most notable of these species on the Lincoln National Forest. Old burned areas are now largely oak brush, which do not revegetate to conifer species easily.

Concurrent with active fire suppression were logging activities. An extensive network of railroad tracks and facilities for logging existed up until the mid 1900's. This railroad logging took place in nearly every drainage on the Lincoln National Forest, leaving little land untouched. The silvicultural treatment was one of highgrading the timber*. This is illustrated

*Bill Stanbrough, timber staff, Lincoln National Forest, 1979: personal communication.

today by large stumps next to mature trees deemed not marketable during harvest. In many areas on the forest this highgrade logging had little effects on the site. Technology of the earlier logging practices resulted in pockets of old growth left due to inaccessability. These pockets quite often are examples of PNV sites. The opening of the sites (decreased canopy cover) by logging in some cases hastened the establishment of Douglas fir and southwestern white pine on those sites previously dominated by ponderosa pine. The combined effects of logging and fire exclusion have resulted in a much different forest than existed before European settlement.

The Lincoln National Forest, like all forests in the Southwest, has had an extensive history of grazing. Sheep, introduced by Spanish settlement, were the earliest domestic animal to use the range. Cattle followed shortly, adding additional pressures to the land. Although the highest grazing pressure occurred in the pinyon-juniper woodland and below, animals also grazed grasses of the timbered areas. Today, even with regulated grazing systems on the forest, species abundance and composition can be altered in the plant communities as a result of grazing. As one might expect, the heaviest use has been in the canyon bottoms and those areas close to water. Every effort was made in this study to avoid those areas where grazing had disrupted the ecosystem structure.

Of the more recent events, recreation has had a large impact on the Lincoln National Forest. This has had an indirect effect on the ecosystem. The increased recreational use of the forest in the last twenty years has led to policy shifts by the administrators of the forest. The establishment of the White Mountain Wilderness area and other recreation sites has taken a large amount of the forest out of active management for non-amenity resources. Direct effects of recreation have primarily resulted in modification of riparian sites or cool drainages. These areas of preferred use are easily adapted

(campgrounds, etc.) to the common mode of recreation, camping.

As can be seen, the most disruptive influence in recent history has been the intervention of man. Modification of prior existing influences on the ecosystem has taken place, as well as the introduction of totally new influences.

METHODS

Field Methods

Primary to any ecological study is the reconnaissance of the area. Reconnaissance is simply observations which aid the researcher in his sampling approach to the region of study. Reconnaissance on the Lincoln National Forest took many forms. The most useful information came from personal communications with Forest Service personnel and local residents of the area. Precise, reliable observations from these people shortened considerably the search time for plot locations. Historical data was also sought from the various ranger districts on the forest. This information was vital to dealing with fire, logging, and grazing conditions of the various ranger districts.

Aerial photographs were also helpful in plot selection. Old canopies and different species composition of the stands could be detected on the photographs with careful study. One problem with the aerial photographs for the Lincoln was the date of the fly over. Most of the photographs were taken in the late 1960's and early 1970's, which presents problems due to harvesting since the photographs were taken.

The selection of sample plots was done in the field, on the ground. Selection was a subjective process relative to the criteria of the investigator and the study. The criteria can be outlined as follows:

1. The presence of old canopy. The canopy should be old enough so that the understory has had time to stabilize.

2. The presence of an understory which has recovered from any past disturbance (no large numbers of disturbance indicators and no physical disturbance such as close grazing).

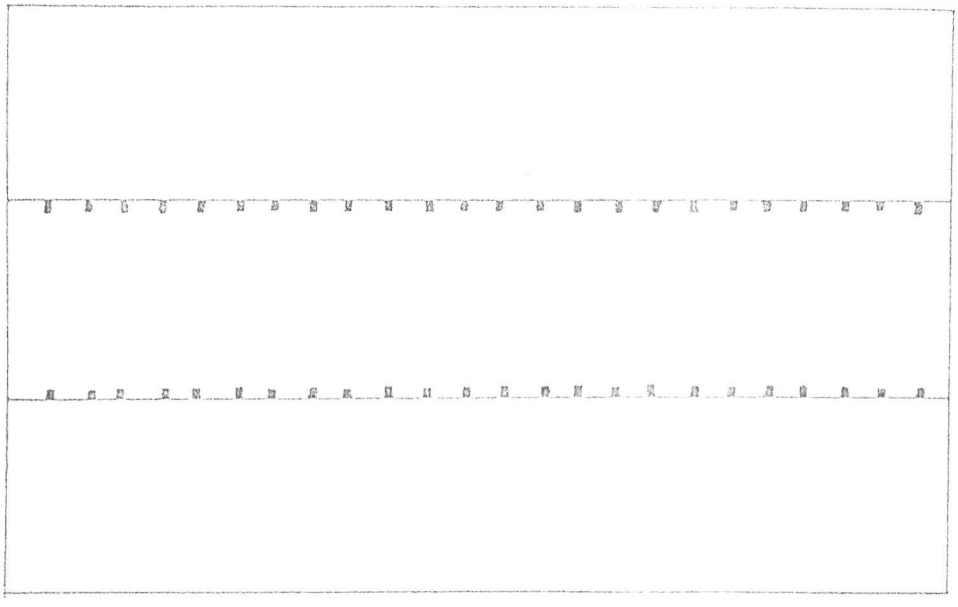
3. The site is part of a larger homogeneous area (Avoid ecotones).

Areas in which the canopy was repeatedly affected by modifying agents can still maintain a mature understory. Mistletoe was a prime agent in producing sites such as this.

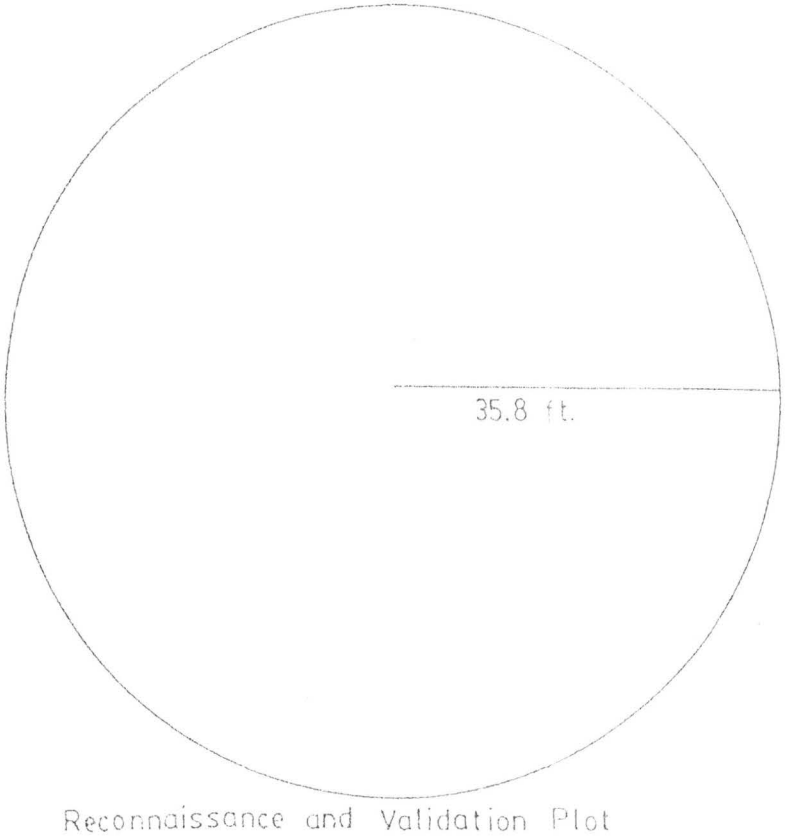
At each site the investigator had the option of three different methods of data collection. These methods were the analytical plot, the reconnaissance plot, and the validation plot. The choice of which plot to use was determined by the needs of the investigator and the objectives of the study.

Analytical plots (Daubenmire 1968) were the underlying basis for estimates on the other plots, reconnaissance and validation. An analytical plot is 15 m wide by 25 m long. Two transect lines, 5 m apart, were run lengthwise through the plot. Along these lines were 1/10 m squared quadrats placed on the inside of the lines at each meter interval (see figure 4). Coverage estimates were then made for those plant species which occurred in the quadrats. On the average, one analytical plot was taken for every 10 plots completed on the forest.

Reconnaissance plots are simply circular plots, 375 m^2 (35.8 ft radius). Coverage data for the plant species in the plot are estimated visually. Validation plots are similar, with a difference in associated data, abiotic, etc. (Figure 4). In order for the visual estimates on the reconnaissance plots and the validation plots to be consistent, the plots were calibrated back to the analytical plots. This means that at every analytical plot a reconnaissance plot is laid over the top. This enables the investigator to compare visual estimates of the reconnaissance with the more standardized results of the analytical plot. Calibration enables two investigators to bring estimates on reconnaissance plots back to the analytical plot, which tends to make the two investigators' values more comparable. This requires the assumption that two people are more likely to agree on estimates made in the analytical quadrats over time than they are relying totally on reconnaissance estimates. Calibrating also enables comparisons between this study and other studies in the western United States, as the analytical plot methods are in common use



Analytical Plot with Quadrat Lines



Reconnaissance and Validation Plot

FIGURE 4: Vegetation Sampling Plots

(Pfister et. al. 1977, Daubenmire 1968B).

At both the analytical plots and the reconnaissance plots a general data plot form is filled out (Appendix A). The general data plot form includes primarily abiotic data and general observations on biotic influences. This information is quite important in associating the classification structure with physical and biotic parameters. This general data plot form is shortened and highly modified for the validation forms (Appendix A).

The data for the plant coverages were recorded on different plot forms. Reconnaissance and validation coverage data are taken to the nearest percentage of plot covered. Analytical plot coverage data are recorded in coverage classes as outlined in Daubenmire (1968). Along with general data and plant coverages, timber data were also included. Trees were recorded in four size classes: 1) seedlings, 2) less than two inch DBH, 3) two to ten inch DBH, and 4) greater than ten inch DBH for reconnaissance plots. On each plot center a prism tally was taken to determine basal area. A site index tree for each species was measured for height, DBH, and age. This timber data are crucial to determining canopy structure and in comparing different sites.

At each plot all species are recorded with their associated coverage values. Those species which could not be identified on the site were collected and identified in the lab. The plot forms were then corrected at a later date when the plants were identified.

Laboratory Methods

Data collected in the field were analyzed in the laboratory. The laboratory procedure basically was a process of refinement to develop an ordering of samples into representative units of a classification. The data were transferred from the plot forms to computer cards, for use in data ordering programs. The computer was the major tool used to bring out trends in the data set.

The data were ordered, via the computer program, into relevee tables (Becking 1957). The tables are a data matrix composed of coverage values oriented by plots and species. Those species which would occur as a trace on quadrats of an analytical plot were displayed as a -9. Those species which would not occur in quadrats of an analytical plot but would occur as a trace in the reconnaissance plot were recorded as -99. To the right of the table are values for the number of observations, frequency, coverage sums, and importance values for each species. The importance value is computed as the square root of the frequency times the sum of coverage. These values are used to distinguish those species important to the classification of agroup of stands from those species which may not be important. Generally those species with higher values for these computations have a higher value for classification purposes. Frequency was found to be an important element in the reliability of a species as a representative of a group of stands.

The plots for the entire forest were first ordered into series. The series is a group of stands based on dominant tree overstories. A dominant tree on a climax site is one in which dominance in abundance is matched with reproduction under the canopy. There are six series groupings: Abies lasiocarpa series, Picea engelmannii series, Picea pungens series, Abies concolor series Pseudotsuga menziesii series, and Pinus ponderosa series.

Within the series there are component groupings, which begin to show similarity in species composition. These groups can be further refined using the habitat type relevee table. At this stage the groupings are only preliminary. Analysis of the total species list from plots and reference to the Stands' historical and abiotic features are crucial to insure validity of the group. The investigator will continue this refinement process until the stands

have been ordered into representative units called habitat types. Habitat types can be further broken down into the phase level. The phase level is a group of stands that retains the habitat type characteristics in overstory and understory, but differs uniformly and predictably in minor vegetative components.

The analysis to this point was highly subjective. Ordination programs were used to bring out any groupings which were not seen in the preliminary analysis, as well as illustrate the groups already developed. Principal component analysis (PCA) was used to compute axes within the data base which accounted for the variability between plots and plant species. The amount of variability that PCA will account for is a product of the number of axes the investigator uses. Quite often groupings of the data can be found at a low level, low number of axes, which account for low amounts of variation. This illustrates the importance of indicator species that separate plots which also have many species in common.

The abiotic data were also ordered using a computer program. These data were grouped by those stands determined to represent a habitat type. Revisions in the habitat type groupings were made based on incongruities in the abiotic data. Again, at this stage a critical evaluation of historical data and other information not readily available from the computer programs was essential to placing any stand in a particular group.

After the decision about the groups was made, a field key to the habitat types and phases was drawn up (see results).

RESULTS

Table 1 lists all of the habitat types and phases of those types for the Lincoln National Forest. This list includes those habitat types found in Moir and Ludwig (1979) and those types developed in this classification scheme. Subsequent descriptions are of habitat types sampled in this study only.

Nomenclature for the habitat types was arrived at primarily by incorporation of the dominant species into the name used. Where habitat types were similar to other types found outside the study area, the already accepted name was used for conventionality. Habitat types represented by very few plots were determined by comparison of those plots with plots of a nearby region. Data from the Gila and Cibola National Forests aided in this aspect of the analysis.

Each habitat type description begins with a discussion of diagnostic vegetation. The diagnostic vegetation are those plant species, overstory and understory, which characterize the habitat type. The overstory tree species are described in terms of their climax and successional roles within the habitat type. The plant species which are most important with respect to presence-absence in the habitat type are labeled diagnostic. Other plants are discussed which are not as important as the diagnostic species but do offer clues to field identification of the habitat type. Any coverage values which are given are not absolute for a species.

A generalized topographical description is also given for each habitat type. Since environmental factors are highly interactive, any number of topographical situations may support the same habitat type. There are situations, however, where a habitat type is restricted to a particular topographical situation. An example can be found in the Abies concolor-Pseudotsuga menziesii/Acer grandidentatum habitat type.

Table 1: List of Habitat Types for the Lincoln National Forest

Habitat Name	Abbreviation
Abies lasiocarpa series	
*1. *Abies lasiocarpa/Senecio sanguisorboides* Ht.	ABLA/SESA HT
Picea engelmannii series	
*2. *Picea engelmannii/Acer glabrum* Ht.	PIEN/ACGL HT
*3. *Picea engelmannii/Elymus triticoides* Ht.	PIEN/ELTR HT
Picea pungens series	
*4. *Picea pungens/Poa pratensis* Ht.	PIPU/POPR HT
5. *Picea pungens-Pseudotsuga menziesii/Fragaria ovalis* Ht.	PIPU-PSME/FROV HT
6. *Senecio cardamine* phase	SECA PH
7. *Picea pungens-Pseudotsuga menziesii* Ht.	PIPU-PSME HT
Valeriana acutiloba phase	VAAC PH
Abies concolor series	
8. *Abies concolor-Pseudotsuga menziesii/Acer grandidentatum* Ht.	ABCO-PSME/ACGR HT
9. *Holodiscus dumosus* phase	HODU PH
*10. *Abies concolor-Pseudotsuga menziesii/Elymus triticoides* Ht.	ABCO-PSME/ELTR HT
11. *Abies concolor-Pseudotsuga menziesii/Acer glabrum* Ht.	ABCO-PSME/ACGL HT
Holodiscus dumosus phase	HODU PH
12. *Abies concolor-Pseudotsuga menziesii/Quercus gambelii* Ht.	ABCO-PSME/QUGA HT
13. *Holodiscus dumosus* phase	HODU PH
*14. *Festuca arizonica* phase	FEAR PH
15. *Muhlenbergia virescens* phase	MUVI PH
16. *Muhlenbergia dubia* phase	MUDU PH
*17. *Abies concolor-Pseudotsuga menziesii* Ht. (Sparse)	ABCO-PSME HT (SPARSE)
18. *Abies concolor/Juglans major* Ht.	ABCO/JUMA HT
Pseudotsuga menziesii series	
19. *Pseudotsuga menziesii/Quercus gambelii* Ht.	PSME/QUGA HT
20. *Holodiscus dumosus* phase	HODU PH
Pinus ponderosa series	
21. *Pinus ponderosa/Quercus gambelii/Quercus gambelii* Ht.	PIPO/QUGA/QUGA HT
22. *Pinus ponderosa/Quercus undulata* Ht.	PIPO/QUUN HT
23. *Muhlenbergia dubia* phase	MUDU PH
24. *Pinus ponderosa/Quercus undulata/Muhlenbergia longiligula* Ht.	PIPO/QUUN/MULO HT

*Habitat types described in Moir and Ludwig (1979)

Soil descriptions for the habitat types are based on soil surveys and mapping as prepared by the soil scientists on the forest. Soil surveys were not completed for the southern half of the forest, Sacramento Mountains, resulting in partial data for some habitat types.

From field observations, adjacent habitats and ecotones can be generalized. Abrupt changes from one habitat type to another are not uncommon on the Lincoln National Forest. A discussion of the habitat type concludes the description of the type.

Picea pungens Series

(5) Picea pungens-Pseudotsuga menziesii/ Fragaria ovalis habitat type PIPU-PSME/FROV HT

(6) Senecio cardamine phase SECA PH

Diagnostic Vegetation. Picea pungens is always a climax element of the PIPU-PSME/FROV HT. Picea pungens shares this climax status with Pseudotsuga menziesii. Both species exhibit between 60 and 80 square feet of basal area per acre. Abies concolor is nearly always present on sites of this habitat type but as a minor climax species. Picea engelmannii is an occasional overstory component. Further work is needed to determine if Picea engelmannii delineates a phase of the PIPU-PSME/FROV HT. Pinus strobiformis is an accidental component of this habitat type.

The shrub layer of this habitat type is highly variable. Holodiscus dumosus and Acer glabrum are the most common elements of the understory stratum. Sites of this habitat type quite often have no shrub component at all and the two species mentioned have little constancy.

There are three major species of the grass component. Poa pratensis is the most common species and can cover as much as 80% of a plot. This species

also shows up with high coverage in Moir and Ludwigs' Picea pungens-Pseudotsuga menziesii/Poa pratensis habitat type. After careful analysis it is felt that the representative plots sampled on the LNF better fit into the PIPU-PSME/FROV HT which is a common type of the adjacent Gila National Forest (Fitzhugh, Moir and Ludwig, in press). Bromus richardsonii and Trisetum montanum are also common on these sites.

The forb layer is more consistent than most habitat types. Fragaria ovalis and F. bracteata are nearly always present. Cystopteris fragilis, Galium asperrimum, Dugaldia hoopesii (Helenium hoopesii), Iris missouriensis, Oxalis alpina, and Pseudocymopteris montanus are all common components of this habitat type.

Senecio cardamine phase. The SECA phase of the PIPU-PSME/FROV HT is similar to the above descritpion with the exception of the high coverage and presence of Senecio cardimine. This phase was only sampled once on the LNF. The sample fits well with the description of the phase found in Fitzhugh, Moir and Ludwig (in press).

Topography. This habitat type is restricted to canyon sideslopes near canyon bottoms. It is found at elevations from between 8000 feet (2440m) and 9000 feet (2745 m), always on northern exposures.

Soils. All plots sampled of this habitat type were found in the Sacramento Mountains; hence, there are no soil descriptions for this habitat type. Site observations find a well developed O layer for the soil and a fine textured loamy soil below that.

Ecotones and Adjacent Habitats. Below the canyon sideslopes, directly in the stream alluvium is the Picea pungens/Poa pratensis habitat type as described by Moir and Ludwig (1979). This type differs in that it lacks the mixed

mixed conifer species, Abies concolor and Pseudotsuga menziesii. Above the PIPU-PSME/FROV HT the adjacent habitat type is variable. A most common situation is to find the Abies concolor-Pseudotsuga menziesii/Acer glabrum habitat type Holodiscus dumosus phase directly up slope. If the slope of the canyon continues to maintain its mesic nature the Picea pungens-Pseudotsuga menziesii habitat type Valeriana acutiloba phase can be found.

Discussion. The PIPU-PSME/POPR HT is not an extensive habitat type on the Lincoln National Forest. Samples of this type were only found in the Sacramento Mountains. Between the field work of Moir and Ludwig (1979) and of this study, all known stands of Picea pungens were sampled . More plots of this habitat type are needed to more clearly define its characteristics, particularly whether or not the occurrence of Picea engelmanii warrents a phase of this habitat type.

The PIPU-PSME/FROV HT, because of its restriction to canyons, has the potential to be heavily used for recreation purposes. Because of their rarity on the forest, Picea pungens stands should be critically evaluated as to their response to any disturbance a management prescription may cause.

(7) Picea pungens-Pseudotsuga menziesii/ habitat Type
Valeriana acutiloba phase
PIPU-PSME/ HT VAAC PH

Diagnostic Vegetation. Picea pungens and Pseudotsuga menziesii are co-dominants of the overstory in the climax condition of this habitat type. Abies concolor is a minor part of the climax tree species. Pinus strobiformis is a minor component of the overstory. Picea engelmannii is absent from this habitat type.

The shrub layer is fairly well developed in this habitat type. Holodiscus dumosus and Quercus gambelii are common elements of this stratum of the

understory. Q. gambelii is minor in the area it covers but is still very common.

The grass understory is poorly represented in this habitat type. Poa pratensis is minor and usually absent. Bromus richardsonii is the most common grass species to occur in this type. Forbs are also not well represented here, with the exception of Valeriana acutiloba. This species is diagnostic for delineation of the VAAC phase of this habitat type.

Topography. The PIPU-PSME/ HT VAAC PH is found on canyon sideslopes, between 8000 feet (2440 m) and 9000 feet (2745 m) in elevation. This type always occurs on northern aspects.

Soils. Soils information is again sketchy for this habitat type as all the samples were collected in the Sacramento Mountains. The litter and O layers are well developed. The soils are often fine loams with little rock material.

Ecotones and Adjacent Habitats. This is the driest of the Picea pungens habitat types on the Lincoln National Forest. Upslope from this habitat type is usually some component of the Abies concolor series. Commonly the ABCO-PSME/QUGA HT HODU PH is present. Downslope in the wetter parts of the canyon the PIPU-PSME/FROV HT can be found.

Discussion. This habitat type, like the PIPU-PSME/FROV HT, is highly restricted on the Lincoln National Forest. All known locations of Picea pungens stands were sampled*. Any of the habitat types that are restricted to the moist canyons of the forest are subject to heavy use by recreationalists. Care should be exercised when prescribing management plans whcih directly affect these sites.

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*Timber staff, L.N.F. 1979, personal communication.

Abies Concolor Series

(8) Abies concolor-Pseudotsuga menziesii/ Acer grandidentatum habitat type
ABCO-PSME/ACGR HT

(9) Holodiscus dumosus phase
HODU PH

Diagnostic Vegetation. Abies concolor is the primary timber species which makes up the climax community of this habitat type. Pseudotsuga menziesii is a late successional species but can occur in a climax stand. In younger sites of this habitat type P. menziesii is much more numerous. These younger sites show a dense regeneration of Abies concolor. Pinus strobiformis is always of minor importance in this habitat type, but is common in occurrence. Other timber species, notably Pinus ponderosa, are absent.

The diagnostic tall shrub species is Acer grandidentatum. It is always present with the notable absence of Acer glabrum. A. grandidentatum can be quite high in coverage of a particular site; as plot 851 recorded 60% coverage. These sites of high coverage of A. grandidentatum often have relatively low coverage by the conifer species. Quercus gambelii is always present, but in low coverage.

Bromus richardsonii is the only grass species with any constancy, but generally occurs in small amounts. B. richardsonii was the only grass found in samples of the Holodiscus dumosus phase of this habitat type. A variety of other grasses can be found on sites not in the HODU phase. Carex spp. is a common graminoid in these areas.

The occurrence of numerous forbs in this habitat type is indicative of its cool, moist nature. Thalictrum fendleri is the most common element of the forbs. Both Galium boreale and Smilacina stellata are also quite common. Of interest is the frequent occurrence of Habenaria sparsiflora.

Topography. The ABCO-PSME/ACGR HT is always found in canyons or a cool, moist site of similar conditions. The elevation of this type is variable, from 6500 feet (1982 m) to over 8500 feet (2592 m). The Holodiscus dumosus phase is found in the higher elevations, 7500 feet (2287 m) to 8500 feet (2592 m). This habitat type is generally found on northern aspects, but, if conditions are mesic enough, the type can be found on western and eastern exposures.

Soils. The soil data for the ABCO-PSME/ACGR HT is again not well-developed due to the majority of samples being found from the Sacramento Mountains. The soils are characteristic of cool productive sites-- a fine textured loam with a low rock content.

Holodiscus dumosus phase

The Holodiscus dumosus phase of the ABCO-PSME/ACGR HT is the wetter component of the type. It is characterized by the presence of the diagnostic species Holodiscus dumosus. This phase also has a notable lack of grasses other than Bromus richardsonii.

Ecotones and Adjacent Habitats. The adjacent communities to the ABCO-PSME/ACGR HT are dependent on how abrupt the change in topography and related environmental factors is. In the lower elevations, steep canyons can result in abrupt environmental changes between types. In such a situation the adjacent community may be the Pseudotsuga menziesii/Quercus gambelii habitat type or even the Pinus ponderosa/Quercus gambelii habitat type. Where conditions are not abrupt the adjacent community may be the mesic Abies concolor-Pseudotsuga menziesii/Acer glabrum habitat type Holodiscus dumosus phase.

Discussion. The ABCO-PSME/ACGR HT is the wettest, most mesic, habitat type of the Abies concolor series at its representative elevation. It is a

highly restricted habitat type, being confined to lower canyon slopes. Moir and Ludwig (1979) include the ABCO-PSME/ACGR HT in with the ABCO-PSME/ACGL HT. Evidence from the Lincoln National Forest supports the delineation of the ABCO-PSME/ACGR HT. In those plots where Acer grandidentatum occurred in any abundance, Acer glabrum was notably absent. Also, the restricted nature of this habitat type is in contrast to the relatively ubiquitous ABCO-PSME/ACGL HT.

(11) Abies concolor-Pseudotsuga menziesii/
Acer glabrum habitat type
ABCO-PSME/ACGL HT
Holodiscus dumosus phase
HODU PH

Diagnostic Vegetation. Abies concolor always will be dominant in the stands of this habitat type. If A. concolor is not dominant in the overstory, then regeneration will be dominated by this species. Pseudotsuga menziesii successionally is established earlier than Abies concolor. P. menziesii is usually a climax species on these sites, becoming minor on very old sites. Pinus strobiformis is very similar to Pseudotsuga menziesii in its occurrence, but is rarely as abundant as P. menziesii. Pinus strobiformis does constitute a large element of a climax site of this habitat type. Pinus ponderosa rarely occurs at all in this habitat type.

The tall shrub layer is highly diagnostic for this habitat type. Acer glabrum is always present, anywhere from high percent coverage to low coverage. In this phase of the habitat type, Holodiscus dumosus is always present. Quercus gambelii is a common component but is always in low coverage values, or sometimes absent. Symphoricarpus oreophilus is sometimes present but has little diagnostic value.

The only grass which occurs in any abundance is Bromus richardsonii and is a common component of the understory. Predominant forbs include

Galium boreale, Stellaria longifolia, and Thalictrum fendleri. These forbs can be quite numerous and cover a large percentage of the site.

Topography. The ABCO-PSME/ACGL HT HODU PH is found predominantly on north and northwest facing slopes. Where local sites are very wet and cool it may be found on more westerly slopes. The elevational range is broad, from 8000 feet (2440 m) to over 9500 feet (2897 m). Where it occurs at lower elevations the site will be locally wet and cool. This habitat type will occur along canyon sides and cool drainages. In the upper elevations this habitat type will occur along the tops of ridges and knolls. It is most striking in cool drainages where the adjacent community may be much drier.

Soils. Soils classification data for this habitat type are lacking as most samples were taken in the Sacramento Mountains. The sites range from alluvial deposites to shallow sideslope soils. A litter layer is usually well developed.

Ecotones and Adjacent Habitats. The upper elevations of this habitat type are associated with spruce-fir habitat types. Regeneration of Abies lasiocarpa and Picea engelmannii will grade into this type at this upper elevation ecotone. On drier adjacent sites the Abies concolor-Pseudotsuga menziesii/Quercus gambelii habitat type Holodiscus dumosus phase will share an ecotone with this forest type. In cool, wet drainages where conditions are especially moist the Abies concolor-Pseudotsuga menziesii/Acer grandidentatum habitat type will be found adjacent to the ABCO-PSME/ACGL HT HODU PH.

Discussion. This habitat type and its associated phase is found in cool wet sites. It is well represented on the Lincoln National Forest, being quite a common element of the Sacramento Mountains. Moir and Ludwig (1979)

discuss the successional seres leading up to the climax condition of this habitat type. From the type of fires, infrequent and erratic, a patchiness has resulted in the successional make-up of the stands in this habitat type. The mosiac of seres can result in an occasional Pinus ponderosa being found in this habitat type. These seres can also be dominated by a shrub layer of mostly Quercus gambelii.

The Holodiscus dumosus phase is the only form in which the ABCO-PSME/ACGL HT occurs on the Lincoln National Forest. This study recognizes an ABCO-PSME/ACGR HT as distinct from the ABCO-PSME/ACGL HT. The ABCO-PSME/ACGR HT occurs on much wetter, restricted sites than does the ABCO-PSME/ACGL HT.

(12) Abies concolor-Pseudotsuga menziesii/
Quercus gambelii habitat type
ABCO-PSME/QUGA HT
(13) Holodiscus dumosus phase
HODU PH
(15) Muhlenbergia virescens phase
MUVI PH
(16) Muhlenbergia dubia phase
MUDU PH

Diagnostic Vegetation. Abies concolor and Pseudotsuga menziesii are the principal climax timber species of this habitat type. As the site matures the dominant P. menziesii is replaced by the more shade tolerant A. concolor. On drier sites of this habitat type, P. menziesii maintains itself in a prominent climax role. Pinus strobiformis is highly variable in this habitat type. It is much more prominent on the wetter sites than on drier sites. This timber species is quite often absent from older, near climax sites. Occasional Pinus edulis and Juniperus deppeana can also be found on the drier sites. This is more common on those areas where this habitat type grades directly into pinyon-juniper sites.

Quercus gambelii is by far the prominent shrub component of this forest

type. It occurs in coverage values of 5% or greater. The large clumps of Q. gambelii on these sites may be due to a past disturbance which favored the oak, such as a hot spot of fire.

The grasses of this habitat type are more diverse than that of the wetter ABCO-PSME/ACGL HT. Two species are encountered most often, Bromus richardsonii and Poa fendleriana. Other species range from the mesic Elymus triticoides to the more xeric Muhlenbergia virescens. Forbs are highly variable with few showing good constancy. Thalictrum fendleri is found on most sites of this type. Clematis ligusticifolia is a common element of the Holodiscus dumosus phase of this type.

Holodiscus dumosus phase

The HODU phase of the ABCO-PSME/QUGA HT is characterized by the presence of Holodiscus dumosus. As much as a quarter of a site may be covered by H. dumosus. Quercus gambelii still plays an important role in this phase, with a large coverage of the area. Symphoricarpus oreophilus is also a common component of this type. Clematis ligusticifolia can be found at most sites.

Topography. The ABCO-PSME/QUGA HT HODU PH can be found on north and northwest-facing slopes at lower elevations- 7000 feet (2135 m) to 8000 feet (2440 m). As elevation increases, 8000 feet (2440 m) to 9000 feet (2745 m), the habitat type can be found on more easterly slopes. This phase can be found on canyon slopes, and occasionally on the upslope of ridges.

Soils. This habitat type commonly occurs on Pachic Udic Haploboolls. Sites of this phase of the habitat type have a better developed O layer than do other phases of this habitat type.

Ecotones and Adjacent Habitats. The HODU PH of the ABCO-PSME/QUGA HT

is bordered by the ABCO-PSME/ACGL HODU PH. This ecotone is recognized by a decrease in Quercus gambelii and an increase in Acer glabrum. In the more xeric situation the Holodiscus dumosus drops out and gives way to the Quercus gambelii (typic) phase of this habitat type. There are many areas where the HODU PH of this habitat type is spatially narrow between other types. This is primarily a result of sharp local topography.

Typic phase

The typic phase of the ABCO-PSME/QUGA HT is characterized by a lack of any strong diagnostic species with the exception of Quercus gambelii. Pinus ponderosa begins to play a more prominent role in the succession of these sites to a climax state. Poa fendleriana increases to become a part of the understory component. Holodiscus dumosus is entirely absent from this phase.

Topography. This phase of the habitat type is one of the most widespread types on the Lincoln National Forest. It can occur as low as 7000 feet (2135 m) to higher than 9000 feet (2745 m), in a variety of topographic positions. It is common on north, east, and south slopes of upper canyons and ridgetops.

Soils. The occurrence of this type on soils varies. It was sampled on soils of Pachic Udic Haplοborolls, Typic Eutroboralfs, Typic Udorthents, and on Pachic Udic Argiborolls. Some sites of this habitat type have a great deal of stoniness to the upper horizons as well as poorly developed O layers.

Ecotones and Adjacent Habitats. The prominent adjacent community of moist situations is the Holodiscus dumosus phase of this habitat type. However, any of the more mesic habitat types may be found along this border. The more xeric sites are bordered by either habitat types of the Pseudotsuga menziesii series, PSME/QUGA HT, or of the Pinus ponderosa series, PIPO/QUGA HT.

Under certain conditions this phase may border the Muhlenbergia virescens phase or the Muhlenbergia dubia phase of this habitat type. These are conditions where these phases are not limited by site conditions.

Muhlenbergia virescens phase

The Muhlenbergia virescens phase of the ABCO-PSME/QUGA HT is delineated by the presence of Muhlenbergia virescens on the site. The addition of other more xeric grasses is also common.

Topography. This phase can occur along a wide elevational range from 7000 feet (2135 m) to over 8500 feet (2592 m). On the higher sites it is usually found on south facing slopes. It may tend towards the cooler aspects as it decreases in elevation.

Soils. The relatively few samples found of this type were on Pachic Udic Argiborolls. Moir and Ludwig (1979) found a variety of soil types where this phase could occur. The litter layer was not well developed and the soils did have a large proportion of rock.

Ecotones and Adjacent Habitats. The Muhlenbergia virescens phase of the ABCO-PSME/QUGA HT is a drier mixed conifer type. It can be bordered by types of the Pinus ponderosa series, PIPO/QUGA HT, at lower elevations and by the more mesic ABCO-PSME/QUGA HT at higher elevations. This phase is small in geographic coverage and somewhat limited in distribution on the Lincoln National Forest.

Muhlenbergia dubia phase

The Muhlenbergia dubia phase of the ABCO-PSME/QUGA HT is the most xeric type in the Abies concolor series. It is distinguished by the presence of

Muhlenbergia dubia and is restricted to low elevations. Pinus ponderosa increases in abundance on these sites.

Topography. The MUDU PH is restricted to low elevation canyon bottoms. These sites are mixed conifer between 6500 feet (1982 m) and 7000 feet (2135 m). The sites are north to northeast aspects or in cool drainages of the north sides of mountains. These types are more common in the Capitan Peak area.

Soils. Samples of this phase were found on Typic Eutroboralfs.

Ecotones and Adjacent Habitats. This phase of the ABCO-PSME/QUGA HT is the lowest elevational representative of the Abies concolor series. It can, under restricted topographical boundaries, be bordered by a pinyon-juniper community. The upper elevational border is with the QUGA PH of this type. Often types of the Pinus ponderosa series border the lower elevational limits of this phase.

Discussion. The ABCO-PSME/QUGA HT is the most extensive habitat type on the Lincoln National Forest. The division of the type into the phases represents shifts in the complex environmental factors to which the habitat type reacts. The HODU PH is the mesic end of the moisture gradient, while the MUVI PH and the MUDU PH represent the most xeric conditions for this habitat type.

This habitat type represents the low elevation Abies concolor forest types. There are sites on the Lincoln National Forest where A. concolor grades into a pinyon-juniper type. These areas are the MUDU PH of the habitat type. The two xeric phases of the habitat type, MUVI PH and MUDU PH, are not extensive in their coverage of the forest. Collection of the data from these areas was limited by their restricted occurrence. Further research is needed to refine and more clearly define these two phases of the ABCO-PSME/QUGA HT.

(18) Abies concolor/Juglans major Habitat Type
ABCO/JUMA HT

Diagnostic Vegetation. Abies concolor is the dominant climax timber species of this habitat type. Populus angustifolia is nearly always present but will vary in any kind of dominance over the plot. This species is sometimes only represented by one or two trees that will cover large areas of the plot. Acer negundo will also be present but not as a canopy dominant. Fraxinus pennsylvanica is also present, being more strongly represented in the younger age classes. Juglans major will occur as a minor component of the overstory but is diagnostic in its presence.

Quercus gambelii is common on sites of this habitat type. Its presence is sometimes quite abundant in light of the riparian nature of this habitat type. Vitis arizonica is a common component of the shrub layer. Poa pratensis is the only grass of consequence found in this habitat type. The density of P. pratensis is quite high on some plots. Few forbs show any constancy for this habitat type. Thalictrum fendleri is the only forb to be found at all sites.

Topography. The ABCO/JUMA HT is only found in riparian areas on stream benches. This is a stream side, canyon type. This type is well represented near 7000 feet (2135 m) elevation but may occur lower, below the other timber types. Aspect does not seem to be a determinant of location; rather, a water source is the limiting factor.

Soils. Samples of this type were found on Udic arguistolls. The soils are very rocky and have a high sand content. These soils are all alluvium soils. Many sites are washed over during high water, eliminating much of the organic layer.

Ecotones and Adjacent Habitats. The ABCO/JUMA HT is restricted to water courses. These streams and the canyons they are found in traverse many vegetational changes in the elevational changes. This results in a variety of habitat types being adjacent to the ABCO/JUMA HT. In the lower elevations this type can border the pinyon-juniper type. As elevation increases the Pinus ponderosa and Pseudotsuga menziesii habitat types will border this riparian type. Finally, when the stream course becomes cool enough the ABCO/JUMA HT will give way to the other Abies concolor habitat types. The ecotones of this habitat type are quite abrupt and narrow. This is a result of the abrupt occurrence of the ecological requirement, water, along the stream courses that this habitat type is found in.

Discussion. The ABCO/JUMA HT is a typical riparian habitat type. It is quite restricted and can be recognized by its obvious ecological requirement, water. Water in the form of stream courses is not plentiful on the Lincoln National Forest. This results in very limited occurrences of this habitat type.

This restricted habitat type also provides a very dense habitat for wildlife. The avifauna is an obvious inhabitant of this habitat type. The snags, particularly Populus angustifolia, provide good nesting sites for many species of birds. Because of its association with water this habitat type is traveled heavily by wildlife in need of water.

Pseudotsuga menziesii Series

(19) Pseudotsuga menziesii/Quercus gambelii Habitat Type
PSME/QUGA HT
(20) Holodiscus dumosus phase
HODU PH

Diagnostic Vegetation. Pseudotsuga menziesii is the dominant climax tree species of this habitat type. Abies concolor is conspicuous in its absence. P. menziesii is much more abundant on these sites than it is on habitat types of the Abies concolor series. This is evidenced by more regeneration under the canopy. Pinus strobiformis can be considered subclimax in that it is abundant on climax sites but more variable than P. menziesii. Pinus ponderosa plays its most obvious successional role in this habitat type. P. ponderosa is disclimax on these sites, as it is adapted to fire. Many climax sites of this type show old fire-scarred P. ponderosa being replaced by Pseudotsuga menziesii and Pinus strobiformis. No regeneration of Pinus ponderosa is seen in the understory. On many of the drier sites, P. ponderosa may become late successionally, bordering on a climax element. Also in the drier, low elevation sites is the presence of Pinus edulis. This species primarily shows up in the regeneration age classes. It is curious in that it is not adapted well to fire, hence it does not play a role in the P. ponderosa disclimax. It is also not found on the old climax stands of this habitat type. Also, occasional on the drier sites is Juniperus deppeana.

Quercus gambelii is the dominant tall shrub species. As much as thirty percent of the plot was recorded as being covered by this species. A slight increase in the diversity of the shrubs was noticed in the lower elevation sites. Cercocarpus montanus and Rhus trilobata are common elements of these lower sites.

The number of grass species increases in this habitat type over those of the Abies concolor series. Bromus richardsonii is a common element with

sporadic showings by other species. Poa fendleriana, Muhlenbergia pauciflora, Sitanion hystrix, and Stipa pringlei are all occasional but common species in other types.

The forbs that are present exhibit the characteristics of more mesic species. Chaptilia alsophila is a common element of this type. Species such as Galium boreale, Lathyrus arizonicus, and Pseudocymopterus montanus can be expected in the understory.

Holodiscus dumosus phase

Because of its more mesic character this phase of the habitat type exhibits a weaker element of Pinus ponderosa. P. ponderosa is less likely to be a member of the older sites. Pinus edulis becomes only accidental on these sites and Juniperus deppeana becomes rare. Holodiscus dumosus is the diagnostic species to delineate this phase of the habitat type. Quercus gambelii is still quite abundant but is always mixed with H. dumosus. The composition of the grass elements drops in diversity. Bromus richardsonii becomes quite constant, while the other species rarely show up. The forbs increase both in diversity and constancy. Chaptilia alsophila, Cystopterus fragilis, Galium boreale, Geranium caespitosum, Pseudocymopterus montanus, Senecio sacramentanus, Smilicina spp., and Thalictrum fendleri all become more common and can be expected in the herb layer.

Topography. The PSME/QUGA habitat type can be found on canyon sideslopes and ridgetops. The Holodiscus dumosus phase is found on aspects of northwest, north, and northeast. The remainder of the habitat type can be found at all aspects. This habitat type ranges in elevation from 7200 feet (2200 m) to 8500 feet (2592 m).

Soils. Samples of this habitat type were found on Typic Eutroboralfs

and Typic Udorthents. In many cases the O layer was poorly developed and many of the sites were rocky in composition.

Ecotones and Adjacent Habitats. In the higher elevations, this habitat type may occur as a pocket within habitat types of the Abies concolor series. Dry south slopes may exhibit the typic phase of this habitat type. The Holodiscus dumosus phase is generally adjacent to the Abies concolor series and shows up at lower elevations on north slopes. The typic phase commonly borders Pinus ponderosa habitat types at lower elevations. Because this one type borders two series level types, the transition into this type is often obvious. At higher elevations the lessening of Abies concolor, and at lower elevations, the lessening of Pinus ponderosa, as climax elements signify this habitat change.

Discussion. The PSME/QUGA HT is important in light of its successional status on the Lincoln National Forest. Due to the exclusion of fire on the forest, this habitat type has progressed closer to climax conditions. As a result, competition between climax elements and the disclimax Pinus ponderosa has increased. This generally has the effect of lowering productivity of any one species, usually Pinus ponderosa. The increased fire hazard, due to increased fuels, has already been discussed in this text.

This habitat type is also conspicuous in its absence in some areas and presence in other areas. The east slope of the Sacramento Mountains have large areas covered by this habitat type. Much of this area has been burned by catastrophic fires. The northern flanks of the mountains in the northern half of the forest generally do not have large areas of the PSME/QUGA HT. These geographical differences are probably related to the climatic differences attributable in turn to topographical differences.

Pinus ponderosa Series

(21) Pinus ponderosa/Quercus gambelii/Quercus gambelii Habitat Type PIPO/QUGA/QUGA HT

Diagnostic Vegetation. The PIPO/QUGA/QUGA HT is dominated by Pinus ponderosa as the climax timber species. Absence of all other mixed conifer species is important. Only accidental occurrence of Pseudotsuga menziesii and Pinus strobiformis is seen. Pinus edulis and Juniperus deppeana are common but are not part of the climax. The canopy can be sparse or dense, depending on the thinning agents present, such as mistletoe.

Quercus gambelii is the only shrub of consequence in this habitat type. The oak is sometimes clumped due to a past disturbance. The oak clumps give way slowly, if at all, to the Pinus ponderosa. The two most prominent grass species on these sites are Poa fendleriana and Koeleria pyramidata (Koeleria cristata). P. fendleriana is the most constant of the two. These grasses are the more mesic individuals, as compared to grasses of the drier Pinus ponderosa habitat types. Artemisia spp. is usually present, A. ludoviciana being common. Erigeron spp. is also common on these sites as is Lithospermum multiflorum.

Topography. The PIPO/QUGA/QUGA HT is generally found on canyon sideslopes of northwest,north, and northeast exposures. These sites are found near 7000 feet (2135 m) in elevation. This type can be found near ridgetops as well.

Soils. Samples of this habitat type were found on Udic Arguistolls. There is sometimes a good deal of bare ground exposed on these sites, the O layer not being well developed. Some of these sites are subject to surface runoff during heavy rains.

Ecotones and Adjacent Habitats. This habitat type is not as extensive on the Lincoln National Forest as it is on the Apache-Mescalero Indian Reservation. This is a result of topographical relief on the LNF not leveling out at the representative elevation. The most extensive area of occurrence is near the Ruidoso area. At the lower limit of this habitat type it borders with the pinyon-juniper types. Occasionally this type will border the other types of the Pinus ponderosa series, PIPO/MUDU HT being common. At upper elevations this type will border the mixed conifer types. Transitions along the borders of this type are fairly abrupt signaling drier conditions.

Discussion. The PIPO/QUGA/QUGA HT is perhaps under represented in this study. The primary cause for this is disturbance. This is particularly evident in the Ruidoso area. Logging in this area was extensive; removal of all the old trees was common. Many sites today are in dense overstocked stand condition, offering few clues as to the climax condition. Successional studies are needed to establish the extent of forest this habitat type covers.

This habitat type is the common type found in the Pinus ponderosa "stringer" stands. This type of stand is common on mountains such as Carrizo Peak, Jicarilla Mountain, and Capitan Peak.

(22) Pinus ponderosa/Muhlenbergia dubia Habitat Type
PIPO/MUDU HT
(23) Quercus undulata Phase
QUUN PH

Diagnostic Vegetation. Pinus ponderosa is the dominant climax tree species for this habitat type. Signs of regeneration of Pinus edulis and Juniperus deppeana under old site conditions point to a co-climax status for these plants. Under a repetitive fire regime the P. edulis and J. deppeana cannot survive, leading to an overstory of pure Pinus ponderosa. As a result of recent fire

suppression, however, the P. edulis and J. deppeana can survive and grow into the climax condition.

The major shrub in this habitat type is Quercus aff. undulata. In the typic phase Q. undulata covers close to 5% of a plot. Q. undulata readily hybridizes with other species of oak, primarily Q. gambelii and Q. grisea. This can make identification difficult, but oak species in this habitat type usually show some characteristics of Q. undulata.

The grass species of the PIPO/MUDU HT are of great importance. Muhlenbergia dubia is a diagnostic species and is always present. It will sometimes cover as much as 7 to 8% of the site. Muhlenbergia emersleyi can cover as much as M. dubia, though not as diagnostic. Many of the more xeric grasses will appear in this habitat type. Aristida arizonica, Bouteloua gracilis, Bouteloua curtipendula, Lycurus phleoides, and Schizachyrium scoparium (Andropogon scoparius) are all somewhat common to this habitat type. Many of the grasses found in the more mesic forest also appear in this habitat type. Poa fendleriana and Bromus richardsonii can be found on these sites.

The forbs on this drier Pinus ponderosa habitat type are not a well developed component of the understory. No one species has good constancy for this habitat type. Artemisia ludoviciana, Erigeron divergens, and Lithospermum multiflorum were found in 50% or more of the plots sampled in this type.

Quercus aff. undulata Phase

The Quercus aff. undulata phase of this habitat type is typified by the increase in abundance of Q. undulata. On these sites Q. undulata increases from 5% to well over 15% of the site. This species becomes the dominant understory element on these sites.

Topography. The PIPO/MUDU HT is found on most all topographical situations,

most abundantly on eastern to southeastern aspects. The habitat type will be found on more westerly positions at lower elevations. This type can be found between 6500 feet (1982 m) and 8000 feet (2440 m). It occurs most commonly around 7000 feet (2135 m).

Soils. Samples of this habitat type were found on Typic Haploboralls, Udic Haploborolls, and Typic Eutroboralfs. The O layer was quite often missing from these soils. These sites looked as though they were surface washed during heavy rains.

Ecotones and Adjacent Habitats. As this is one of the driest timber types on the Lincoln National Forest, it always borders the pinyon-juniper in its lower elevational limits. Transition in the upper limits is to the PIPO/QUGA HT or to the PSME/QUGA HT. This habitat type, as it occurs in stringers, will sometimes border the ABCO-PSME/QUGA HT MUDU PH. The areal extent of this habitat type is not great, as it often is transitional on steep slopes between pinyon-juniper types and mixed conifer types.

Discussion. The PIPO/MUDU HT is not an extensive timber habitat type. For this reason disturbance is not as common in this type as in the PIPO/QUGA HT. Pinus ponderosa is near its physiological limit on these sites. Moisture stress and competition with the oak exemplify this.

Fire is an important historical element of this habitat type. The pattern of fires appears to be similar to that of the pinyon-juniper woodland- high intensity and low frequency. Evidence of catastrophic fires was not uncommon in this type.

Of interest is the diversity of this type on the eastern flank of Capitan Peak. The Chinquapin oak, Quercus muehlenbergii Engelm., appears in the canyon soils where this type occurs. On the canyon sideslopes there is much more

(23) Pinus ponderosa/Quercus undulata Ht.
Muhlenbergia dubia phase
PIPO/QUUN MUDU PH

Diagnostic Vegetation. The PIPO/QUUN HT MUDU PH is very similar in vegetation composition to the PIPO/MUDU HT. The overstory is climax to Pinus ponderosa. Pinus edulis and Juniperus deppeana may play a more dominant role than in the PIPO/MUDU HT. The major vegetational shift is in the occurrence of Quercus undulata. Quercus undulata increases from 5% to well over 15% of the site. This species becomes the dominant understory element on these sites.

Muhlenbergia dubia is still diagnostic on these sites. Muhlenbergia emersleyi becomes more common on these sites than on the PIPO/MUDU HT. As a result of the increased oak cover the grass cover will decrease to at times less than 1% cover. Constancy by the grasses is still maintained. The forb layer of this habitat type is again not well developed.

Topography. The PIPO/QUUN MUDU HT can be found in nearly every topographical situation. It is found most commonly on south to southeast exposures. It occurs between 6500 feet (1982 m) and 7500 feet (2280 m).

Soils. Samples of this habitat type were found on Typic Haploboralls, Udic Haploboralls, and Tyipic Eutroboralfs. The litter layer is poorly developed on these sites.

Ecotones and Adjacent Habitats. The PIPO/QUUN MUDU HT is always found adjacent to the PIPO/MUDU HT. This is a result of its occurrence where the environmental gradient (moisture, temparature, etc.) is gradual. Given a large breadth, hence a greater resolution, to the environmental gradient, oak will express itself in a broader range of dominance. This broader range of dominance has resulted in the recognition of the PIPO/QUUN MUDU HT. The PIPO/QUUN MUDU HT is most commonly found in the Sacramento Mountains.

(24) Pinus ponderosa/Quercus undulata/Muhlenbergia longiligula Habitat Type
PIPO/QUUN/MULO

Diagnostic Vegetation. There are three primary species of the overstory component. Pinus ponderosa is the dominant tree species. Pinus edulis and Juniperus deppeana show up as regeneration on older sites. This is a result of the frequency of fires being reduced, hence, the pinyon-juniper can become established. The canopy cover of this habitat type is not very thick as a result of dense grass cover.

Quercus undulata is the only shrub of consequence occurring on this habitat type. Coverage by this species is usually low but can increase after disturbance. The grass composition is well developed in the PIPO/QUUN/MULO HT. Muhlenbergia longiligula is a diagnostic species always present. Piptochaetium fimbriatum and Bouteloua gracilis are common elements of this type. Forbs, although present, are not of great abundance. Species of Artemisia are nearly always present but by no means are they diagnostic.

Topography. The PIPO/QUUN/MULO HT can occur at nearly any aspect on canyon sideslopes or ridges. It is most often found between 6500 feet (1983 m) and 7000 feet (2135 m) in elevation.

Soils. Samples of the PIPO/QUUN/MULO HT were found in the Sacramento Mountains, hence, no direct soil data is available. The sites which were sampled had a well developed litter layer, much better than other Pinus ponderosa types. This was primarily a result of the large amount of carry over from the grasses. These sites were also on deeper alluvial soils than surrounding types.

Ecotones and Adjacent Habitats. The PIPO/QUUN/MULO HT is most often

found surrounded by the PIPO/QUGA/QUGA HT. This latter habitat type has much more Quercus gambelii present than does the adjacent PIPO/QUUN/MULO HT. The PIPO/QUUN/MULO HT can also border the pinyon-juniper habitat types. This was common in the southern Sacramento Mountains.

Discussion. The PIPO/QUUN/MULO HT is again not an extensive habitat type on the Lincoln National Forest. Its greatest abundance is in the eastern and southern Sacramento Mountains. It is probable that this type also occurs in the northern half of the forest, near the Ruidoso area. The great abundance of grasses on sites of this habitat type is noteworhty. The question must be asked if a high productivity rate is common to this type.

Keys to the Series Level and Habitat Types of the Lincoln National Forest

What follows are dichotomous keys for the series level and habitat types of the Lincoln National Forest. Habitat types described in Moir and Ludwig (1979) and in this study are included.

The first step in the keying process is to determine the series level of a particular site. The user of the series level key must determine which overstory tree species is climax for the site. A climax species is well represented in the overstory of mature sites with reproduction in the understory. Younger sites will show reproduction of the climax species under the canopy and may not show the species in the overstory. The field investigator must judge whether this reproduction will grow to the dominant climax species when the site matures. This becomes more difficult the younger the site is. The investigator will find sites of the Abies concolor series presenting the most problems in this respect. Pinus ponderosa will also present problems in that it may not be prolific in reproduction on drier sites. The investigator must carefully search sites of ponderosa pine/pinyon-juniper for reproduction of P. ponderosa to determine climax species.

Diagnostic species may not always be present in a particular habitat type due to lack of seed source or disturbance. The investigator is forced to compare the site to the written description to determine habitat types. When choices in the keys are not clear due to site conditions, the written descriptions and synoptic tables should be used to distinguish types.

Key to Series Level

1a PIEN or ABLA present in the overstory or regeneration under canopy sufficient to show these two species as climax species, PIPU absent.

2

1b PIEN and ABLA absent or if present then PIPU also present.

3

2a ABLA present in overstory and or reproduction.

ABLA/SESA HT (1)*

2b ABLA absent or accidental.

PIEN series 2s
(page 50)

3a PIPU present in overstory and or reproduction.

PIPU series 3s
(page 50)

3b PIPU absent, other species present; ABCO, PSME, or PIPO.

4

4a ABCO present in overstory or as a prominent element of the understory. ABCO not accidental, truly climax. Other species may be present but not climax dominants.

ABCO series 4s
(page 50)

4b ABCO absent or accidental, not a dominant component of the overstory.

5

5a PSME clearly the dominant climax species, PIPO late successional, ABCO absent or accidental.

PSME series 5s
(page 52)

5b PSME not a strong element of either overstory or understory. PIPO the climax dominant.

PIPO series 6s
(page 52)

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*Description of habitat type can be found in Moir and Ludwig (1979).

2s PIEN Series Key to Habitat Types

1a Low elevation forests, Sacramento Mountains, Acer glabrum present.
PIEN/ACGL HT (2)*

1b Higher elevation forest, Capitan Peak, Elymus triticoides present.
PIEN/ELTR HT (3)*

3s PIPU Series Key to Habitat Types

1a Forests of alluvial soils of valleys, benches.
PIPU/POPR HT (4)*

1b Forests of canyon sideslopes, Pseudotsuga menziesii present.
2

2a Fragaria ovalis common and abundant in understory. No Valeriana acutiloba in understory.
3

2b Fragaria ovalis not common, Valeriana acutiloba present.
PIPU-PSME/HT
VAAC PH (7)
(page 25)

3a Senecio cardamine present.
PIPU-PSME/FROV HT
SECA PH (6)
(page 23)

3b Senecio cardamine absent.
PIPU-PSME/FROV HT (5)
(page 23)

4s ABCO Series Key to Habitat Types

1a Acer grandidentatum present, Acer glabrum absent.
2

1b Acer grandidentatum absent.
3

2a Holodiscus dumosus present, not accidental.
ABCO-PSME/ACGR HT
HODU PH (9)
(page 27)

2b Holodiscus dumosus absent.
ABCO-PSME/ACGR HT (8)
(page 27)

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*Description of habitat type can be found in Moir and Ludwig (1979).

3a Sites in Capitan Mountains, Elymus triticoides abundant in understory.

ABCO-PSME/ELTR HT (10)*

3b Location throughout forest, Elymus triticoides rare.

4

4a Acer glabrum present as a substantial component of the shrub layer, Holodiscus dumosus present in association, Pinus ponderosa absent or accidental.

ABCO-PSME/ACGL HT
HODU PH (11)
(page 29)

4b Acer glabrum absent, Holodiscus dumosus may be present but not in association with Acer glabrum.

5

5a Sites of riparian nature, Juglans major present, Populus angustifolia sometimes present in overstory.

ABCO/JUMA HT (18)
(page 36)

5b Sites not riparian, Juglans major absent.

6

6a Understory extremely sparse, virtually no representative shrub species, total grass cover less than 2 percent of a tenth acre site, diversity extremely low. These are not isolated pockets.

ABCO-PSME/HT (SPARSE)*
(17)

6b Shrubs a definite component, Quercus gambelii very prominent, good representation of grass species.

7

7a Site with high, greater than 5 %, coverage of Quercus gambelii. Holodiscus dumosus, Festuca arizonica, Muhlenbergia virescens, and Muhlenbergia dubia absent.

ABCO-PSME/QUGA HT (12)
(page 31)

7b Site again with good representation of Quercus gambelii but with one of the following species: Holodiscus dumosus, Festuca arizonica, Muhlenbergia virescens, or Muhlenbergia dubia.

8

8a Holodiscus dumosus present.

ABCO-PSME/QUGA HT
HODU PH (13)
(page 32)

8b Holodiscus dumosus absent.

9

9a Festuca arizonica clearly the dominant grass.

ABCO-PSME/QUGA HT
FEAR PH (14)*

9b Festuca arizonica absent.

10

10a Muhlenbergia virescens the dominant grass.

ABCO-PSME/QUGA HT
MUVI PH (15)
(page 34)

10b Muhlenbergia virescens absent, Muhlenbergia dubia the dominant grass.

ABCO-PSME/QUGA HT
MUDU PH (15)
(page 34)

5s PSME Series Key to Habitat Types

1a Quercus gambelii a distinct component and well represented, grass species with high, more than one species, diversity. Holodiscus dumosus absent.

PSME/QUGA HT (19)
(page 38)

1b Quercus gambelii a distinct component, grasses of low diversity, Bromus richardsonii the most dominant grass. Holodiscus dumosus present.

PSME/QUGA HT
HODU PH (20)
(page 39)

6s PIPO Series Key to Habitat Types

1a Quercus gambelii the prominent oak on site, no sign of hybridization with Q. undulata. Poa fendleriana the prominent grass species present.

PIPO/QUGA/QUGA HT (21)
(page 41)

1b Quercus gambelii not the prominent oak, absent or clear evidence of hybridization with Quercus undulata. Q. undulata the dominant oak.

2

2a Muhlenbergia longiligula the dominant grass on site, Pintochaetium fimbriatum prominent as well. Grasses may cover very high percentage of a plot. Muhlenbergia dubia absent.

PIPO/QUUN/MULO HT (24)
(page 46)

2b Muhlenbergia longiligula absent, grasses not covering more than 25% of plot. Muhlenbergia dubia present and dominant. Muhlenbergia emersleyi a codominant at times. Quercus undulata may be quite abundant.

3

3a *Quercus undulata* less than 5% coverage of a tenth acre.
PIPO/MUDU HT (22)
(page 42)

3b *Quercus undulata* very abundant clearly over 5% coverage of a tenth acre.
PIPO/QUUN HT
MUDU PH (23)
(page 45)

SUMMARY AND DISCUSSION

There are twenty-four timbered habitat types and phases on the Lincoln National Forest. These types represent six tree species series. Seventeen of the habitat types and phases are described in this study, with the remaining seven types described by Moir and Ludwig (1979). Types range from the mesic Picea engelmannii series to the xeric Pinus ponderosa series. This study offers a means to divide the diversity on the forest into recognizable units. Through correlative studies these units can be valuable tools for the land manager.

The Picea engelmannii series and the Abies lasiocarpa series are found in the higher elevations of the Sacramento Mountains, the White Mountains, and the Capitan Mountains. These series represent the most mesic timbered types along the moisture gradient on the Lincoln National Forest. These series represent two of the southern-most spruce-fir forest types in the United States. The description of these habitat types in Moir and Ludwig (1979) differ from those described in studies conducted in the northern parts of the Rocky Mountains (Daubenmire 1943 1952, Ellison 1954, Langenheim 1962, Oosting 1952, Pfister et al 1977, Steele et al 1981). These differences are a product of isolation and lack of genetic exchange between the Lincoln National Forest and other areas in the region.

The Picea pungens series is a very restricted group of habitat types. Picea pungens is not an extensive timber species in the southwestern United States, and this is certainly true of the Lincoln National Forest. These habitat types are indicative of cool, moist canyons of mid-elevations. Occurrence of this series along the moisture gradient is displaced relative to its occurrence along an elevational gradient. This signifies a topographical situation resulting in a more mesic situation at a lower elevation. This exemplifies

the complex nature of moisture and elevational gradients.

The Abies concolor series is the most extensive series on the Lincoln National Forest. This great geographic coverage results in a great diversity of habitat types within the series. This series includes a shift from a lower quality softwood, Abies concolor, to higher quality softwoods, Pseudotsuga menziesii, Pinus strobiformis, and Pinus ponderosa. The mesic habitat types of this series are dominated by Abies concolor even in the earlier seral stages. The drier types are still climax Abies concolor, but successionally are dominated by Pseudotsuga menziesii, Pinus strobiformis, and Pinus ponderosa. This points to the importance of disturbance in maintaining the timber quality of these sites.

The Pseudotsuga menziesii series presents an interesting question to the forest ecologist. Is the Pseudotsuga menziesii series a climatic climax element or are the pure stands of Pseudotsuga menziesii a result of a lack of seed source of Abies concolor? A critical evaluation of these sites must be made to determine if the site is disturbance maintained to the exclusion of Abies concolor, or if it truly is a response to climatic conditions. Evidence from this study supports the view of a climatic climax Pseudotsuga menziesii series. Sites which have no Abies concolor were found adjacent to, but on a different aspect than, sites which were dominated by Abies concolor. This would rule out the lack of a seed source for Abies concolor. No disturbance element could be found on these sites which would account for the absence of Abies concolor. However, there certainly are sites where the lack of Abies concolor is attributable to a disturbance factor. These factors are most often related to low intensity fires or a biotic agent, mistletoe, which opens the canopy to the point where solar intensity is too great for Abies concolor to become established.

The Pinus ponderosa series of the Lincoln National Forest is a series of

great commercial potential, but of relatively small size on the forest. The climatic climax area of Pinus ponderosa is not a wide, extensive area on the forest. It is this series which occupies those regions between the pinyon-juniper woodland and the mixed conifer sites. Quite often it is absent or occurs in a narrow transition zone between the mixed conifer and the pinyon-juniper woodland. Prior to exclusion of the low-intensity fires on the forest, pure stands of Pinus ponderosa represented a disclimax adaptation to fire. This resulted in the maintenance of disclimax Pinus ponderosa types which extend into lower elevational mixed conifer sites and into the upper elevational pinyon-juniper sites. As a result of increased fuel loading due to fire exclusion, the Pinus ponderosa series is often highly disturbed as a result of catastrophic fires, making sampling in the present study difficult. Grazing has also been a common disturbance factor in this series. This is particularly true of the Sacramento Mountain region where grazing has altered the climax species composition. This could result in difficulty in using the habitat type key in that area.

Successional Trends. Disturbance has been and always will be a major ecological element on the Lincoln National Forest. Prior to European settlement, fire was the major form of disturbance. As a natural part of the ecosystem, fire exerted adaptive pressures on the species which inhabit the ecosystem. This adaptation is most evident in the disturbance climax Pinus ponderosa forest.

In sampling the forest for this study it became apparent that pure Pinus ponderosa stands once occupied a larger percentage of the Lincoln National Forest than they do today. Evidence of this can be seen where the mature overstory of Pinus ponderosa is being replaced by the mixed conifer species, Pseudotsuga menziesii, Pinus strobiformis, and Abies concolor. Given the assumption of tolerance of fire by Pinus ponderosa and susceptibility to fire

by the other species, the conclusion is that these stands were once Pinus ponderosa disclimax.

The exclusion of fire from the forest has provided a means for the overstory to express its climatic climax ranges. This has led to a decrease in the amount of pure Pinus ponderosa on the Lincoln National Forest. Without fire, or a substitute disturbance with similar effects, these sites will become mixed conifer sites which may be less valuable commercially than pure stands of Pinus ponderosa. Value on these sites is lowered due to a number of factors:

1. Increased competition between species, resulting in a lower productivity of the site.
2. A switch to less desirable species.
3. Nutrient cycling process disrupted due to lack of fire.
4. Increased fuel loading resulting in a greater loss to catastrophic fire and increased suppression costs.

To deal with this obvious successional change the land manager on the Lincoln National Forest must adopt management policies which recognize these changes. If fire is not used as a management tool the land manager must shift from managing for a single species, Pinus ponderosa, to managing for a mixed conifer stand.

Since European settlement, grazing has become a major disturbance factor affecting ecosystems on the Lincoln National Forest. The primary influence of grazing is to change the composition of the understory species. This is particularly evident in the Pinus ponderosa habitat types which have abundant grasses for grazing. A common sight on the forest is a canopy of mature trees with understory compositions dominated by disturbance (grazing) indicator species.

Current Applications and Future Research Needs. The primary use of this study in the forest land management will be to divide the diverse Lincoln

National Forest into definable units. The real value of a study such as this can only be realized by a continued effort to refine the divisions and in correlating prescription information to the units. The refining process can best be accomplished by successional studies. These successional studies will identify stages in ecosystem development towards the climax condition. This will enable the forest land manager to identify a given area as to a habitat type regardless of its condition relative to disturbance. When information about a particular managment prescription is correlated with the habitat type, the land manager then has some predictive capability based on data. This predictive information is then easily communicated to newly arrived foresters on the forest.

Correlative studies do not always answer all the predictive questions about a particular habitat type. Many habitat types will react the same relative to a single prescription treatment. In this case no division is needed between those habitat types with the same response. This points to the need of the land manager making judgments about the resolution needed within a particular classification scheme.

The results of this study are not presented as the ultimate classification scheme for the Lincoln National Forest. This study is offered as the basis for further research in designing a classification scheme that the land manager can find applicable for all uses. Studies such as this are links between abstract research and the applied uses of the research.

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APPENDIX A: DATA PLOT FORMS

GENERAL-DATA PLOT FORM Photo No. _____ Observer _____

Plot No. _____ ELEV _____ ASPECT _____ SLOPE _____ DATE _____
Location: _____
T _____ R _____ S _____ Q _____ USFS QUAD _____

Landform _____ Position __ Ridge __ Upper __ Mid __ Lower __ Bench __ Stream __ Other ___

Soil Surface: Soil _____ Rocky _____ Litter _____ Moss _____ Veg BA _____ =100%

Soil PM _____ Mapping Unit _____

% Surface stoniness (describe) _____

% Exposed bedrock _____

Surface/subsurface drainage (describe) _____

Natural Erosion Tendencies (describe) _____

Soil Rooting Depth _____

Nature of Bedrock & Root Penetration _____

% Solum stoniness (rock + gravel by volume) _____

GENERAL OBSERVATIONS

Fire History _____

Logging influence _____

Grazing Influence:
No change in species cover or presence _____
Change in species cover only (note species & change) _____
Change in species presence (detail) _____
Change in Life Form _____
Mistletoe: L __ M __ H __ Evidence _____ Species _____
Canopy Cover (%) _____
General Stand Description and areal extent _____

Species Composition Shifts in Stand _____
(Relate to environmental factors) _____

Adjacent Communities:
Higher _____ More Moist _____
Lower _____ Less Moist _____
Rocky Areas _____ Other Environmental factors _____

Other _____

RECONNAISSANCE-PLOT FORM (Ponderosa Pine Series) Keys to _____ h.t./phase

Plot No. ____

Dominant Understory: Height ____ Species _____ Date _____ Observer _____
Dominant Stand: Height ____ DBH (tallest tree)____ Estimated Age____ Species _____

TREES	PRISM TALLY	SEED-LINGS	DBH < 2"	DBH 2-10"	DBH > 10"
Abco					
Jude					
Jumo					
Jusc					
Juut					
Pien					
Pied					
Pipo					
Pist					
Potr					
Psme					
Quga					
Qugr					
Quhv					
Dead					

Prism Factor _____

SHRUBS	COVER	NOTES
Art		
Bere		
Cefe		
Cemo		
Chna		
Chvi		
Cost		
Quga		
Qutu		
Qugr		
Quhv		
Rosa		

Site Index Trees:
1. Age(BH)____ ± ____ Dia(BH)____ HT____
2. Age(BH)____ ± ____ Dia(BH)____ HT____
3. Age(BH)____ ± ____ Dia(BH)____ HT____

PERENNIAL FORBS

SPP	COVER	NOTES
Artemesia		
Astragalus		
Anpa		
Anma		
Castelleja		
Cirsium		
Ericeron		
Eriogonum		
Erra		
Frov		
Geranium		
Gilia		
Hife		
Calliandra		
Howr		
Limu		
Pece		
Psmo		
Penstemon		
Semu		
Sene		
Sewo		
Solidago		

GRAMINOIDS	COVER	NOTES
Andropogon		
Aristida		
Bltr		
Bogr		
Bromus		
Carex		
Fear		
Koer		
Mulo		
Numo		
Muvi		
Pofe		
Poco		
Popr		
Poa		
Sihy		
Silo		
Stipa		

VALIDATION-PLOT FORM

DATE_____

Habitat Type_____Phase_____Observer_____

Plot No._____Elev._____Aspect_____Slope_____

Location: T____R____Sec.____Q____Area_____

Landfrom_____Position: Ridge_____Upper_____Mid_____

Lower_____Bench_____Stream_____Terrace_____Other_____

Soil Surface: Soil_____Rocks_____Litter_____Moss_____Veg BA_____=100%

Distrubances which influence herbaceous cover:

Type:_____

Nature of change due to disturbance_____

Adjacent Communities: More moist_____

Less Moist_____Other_____

Dominant and Indicator Plants:

Trees	0-2"	2-10"	>10"	Forbs	% cover

Shrubs	% cover		% cover

Site Tree:_____Diam_____Ht._____Species_____

VEGETATIVE COVER FORM (All Forest Series -- analytical plots) Observer:_____Date:_____

Plot No:_____ (See GENERAL DATA PLOT FORM for location and other data)

Cover classes (vegetation): 0-1% = T; 1-5% = 1; 5-25% = 2; 25-50% = 3; 50-75% = 4; 75-95% = 5; 95-100% = 6

Soil Surface Cover (Actual) Percentages = 100%): Rock, Exposed mineral Soil, Litter (all types), Moss, Vascular Plant Basal area (BA).

QUADRAT NUMBER

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	T	0	1	2	3	4	5	6	Σ

Appendix B
Plant List of all Species Identified in Study*

Trees

	Abbr.
Abies concolor	ABCO
Acer negundo	ACNE
Fraxinus pennsylvanica	FRPE
Juglans major	JUMA
Juniperus deppeana	JUDE
Juniperus monosperma	JUMO
Juniperus osteosperma	JUOS
Juniperus scopulorum	JUSC
Picea pungens	PIPU
Picea engelmannii	PIEN
Pinus edulis	PIED
Pinus ponderosa	PIPO
Pinus strobiformis	PIST
Populus angustifolia	POAN
Populus tremuloides	POTR
Pseudotsuga menziesii	PSME

Shrubs

Acer glabrum	ACGL
Acer grandidentatum	ACGR
Berberis fremontii	BEFR
Berberis repens	BERE
Ceanothus fendleri	CEFE
Cercocarpus montanus	CEMO
Cornus stolonifera	COST
Fallugia paradoxa	FAPA
Fendlera rupicola	FERU
Gutierrezia sarothrae	GUSA
Holodiscus dumosus	HODU
Jamesia americana	JAAM
Lonicera involucrata	LOIN
Parthenocissus inserta	PAIN
Physocarpus monogynus	PHMO
Prunus virginiana	PRVI
Ptelea trifoliata	PTTR
Quercus gambelii	QUGA
Quercus grisea	QUGR
Quercus muehlenbergii	QUMU
Quercus undulata	QUUN
Quercus X (hybrid)	QUER X
Rhamnus betulaefolia	RHBE
Rhamnus californica	RHCA
Rhus radicans	RHRA

*Nomenclature referenced to Lohr, 1979.

Appendix B cont.

Rhus trilobata	RHTR
Ribes spp.	RIBES
Ribes cereum	RICE
Ribes inerme	RIIN
Ribes montigenum	RIMO
Ribes pinetorum	RIPI
Ribes wolfii	RIWO
Robina neomexicana	RONE
Rosa spp.	ROSA
Rosa arizonica	ROAR
Rubus neomexicanus	RUNE
Rubus parviflorus	RUPA
Rubus strigosus	RUST
Salix scouleriana	SASC
Sambucus glauca	SAGL
Sambucus microbotrys	SAMI
Symphoricarpos oreophilus	SYOR
Vitis arizonica	VIAR
Yucca angustissima	YUAN
Yucca baccata	YUBA

Graminoids

Agropyron trachycaulum	AGTR
Andropogon gerardi	ANGE
Andropogon pseudorepens	ANPS
Aristida arizonica	ARAR
Blepharoneuron tricholepis	BLTR
Bouteloua curtipendula	BOCU
Bouteloua gracilis	BOGR
Bromus spp.	BROMUS
Bromus marginatus	BRMA
Bromus richardsonii	BRRI
Carex spp.	CAREX
Carex foena	CAFO
Carex occidentalis	CAOC
Carex rossii	CARO
Carex siccata	CASI
Cyperus fendlerianus	CYFE
Dactylis glomerata	DAGL
Elymus ambiguus	ELAM
Elymus glaucus	ELGL
Elymus triticoides	ELTR
Festuca arizonica	FEAR
Juncus balticus	JUBA
Koeleria pyramidata	KOPY
Luzula parviflora	LUPA
Lycurus phleoides	LYPH
Melica porteri	MEPO
Muhlenbergia dubia	MUDU
Muhlenbergia emersleyi	MUEM
Muhlenbergia longiligula	MULO
Muhlenbergia montana	MUMO

Appendix B cont.

Muhlenbergia pauciflora	MUPA
Muhlenbergia virescens	MUVI
Panicum bulbosum	PABU
Piptochaetium fimbriatum	PIFI
Poa annua	POAN
Poa fendleriana	POFE
Poa leptocoma	POLE
Poa occidentalis	POOC
Poa palustris	POPA
Poa pratensis	POPR
Schizachyrium cirratum	SCCI
Schizachyrium scoparium	SCSC
Sitanion hystrix	SIHY
Stipa spp.	STIPA
Stipa columbiana	STCO
Stipa lettermani	STLE
Stipa pringlei	STPR
Trisetum montanum	TRMO

Forbs

Achillea millefolium	ACMI
Agoseris glauca	AGGL
Allium spp.	ALLIUM
Allium cernuum	ALCE
Androsace occidentalis	ANOC
Antennaria parvifolia	ANPA
Aquilegia elegantula	AQEL
Arabis fendleri	ARFE
Arenaria spp.	ARENAR
Arenaria lanuginosa	ARLA
Artemisia carruthii	ARCA
Artemisia dracunulus	ARDR
Artemisia frigida	ARFR
Artemisia ludoviciana	ARLU
Astragalus spp.	ASTRAG
Astragalus rusbyi	ASRU
Bahia dissecta	BADI
Bidens bipinnata	BIBI
Brickellia californica	BRCA
Brickellia grandiflora	BRGR
Calliandra humilis	CAHU
Campanula rotundifolia	CAROT
Castilleja spp.	CASTIL
Chaetalia alsophila	CHALS
Chenopodium album	CHAL
Chimaphila umbellata	CHUM
Cirsium parryi	CIPA
Clematis ligusticifolia	CLLI
Clematis pseudoalpina	CLPS
Commelina dianthifolia	CODI
Corallorhiza maculata	COMA

Appendix B cont.

Corallorhiza wisteriana	COWI
Cystopteris fragilis	CYFR
Delphinium spp.	DELPHI
Draba aurea	DRAU
Draba helleriana	DRHE
Dugaldia hoopsii	DUHO
Epilobium angustifolium	EPAN
Erigeron divergens	ERDI
Erigeron flagellaris	ERFL
Erigeron macranthus	ERMA
Erigeron platyphyllus	ERPL
Erigeron superbus	ERSU
Eriogonum spp.	ERIOGO
Eriogonum jamesii	ERJA
Erysimum capitatum	ERCA
Eupatorium herbaceum	EUHE
Euphorbia fendleri	EUFE
Euphorbia lurida	EULU
Euphorbia palmeri	EUPA
Fragaria bracteata	FRBR
Fragaria ovalis	FROV
Galium spp.	GALIUM
Galium asperrimum	GAAS
Galium boreale	GABO
Galium microphyllum	GAMI
Galium triflorum	GATR
Galium wrightii	GAWR
Geranium caespitosum	GECA
Geranium richardsonii	GERI
Goodyera oblongifolia	GOOB
Habernaria sparsiflora	HASP
Haplopappus parryi	HAPA
Hedeoma drummondii	HEDR
Hedeoma oblongifolium	HEOB
Heterotheca fulcrata	HEFU
Heuchera parvifolia	HEPA
Hieracium fendleri	HIFE
Hymenoxys richardsonii	HYRI
Ipomopsis aggregata	IPAG
Iris missouriensis	IRMI
Lappula redowskii	LARE
Lathyrus arizonicus	LAAR
Lathyrus eucosmus	LAEU
Lathyrus leucanthus	LALE
Lesquerella gordoni	LEGO
Ligusticum porteri	LIPO
Lithospermum multiflorum	LIMU
Lonicera spp.	LONICE
Lonicera arizonica	LOAR
Lonicera utahensis	LOUT
Lupinus spp.	LUPIN
Lupinus argenteus	LUAR

Appendix F cont.

Lupinus kingii	LUKI
Malaxis soulei	MASO
Melilotus officinalis	MEOF
Mirabilis oxybaphoides	MIOX
Monotropa hypopitys	MOHY
Myosotis scorpioides	MYSC
Oenothera hookeri	OEHO
Opuntia spp.	OPUNTI
Orobanche cooperi	ORCO
Orobanche multiflora	ORMU
Osmorhiza chilensis	OSCH
Osmorhiza depauperata	OSDE
Oxalis alpina	OXAL
Oxytropis lambertii	OXLA
Pachystima myrsinites	PAMY
Pellaea atropurpurea	PEAT
Penstemon spp.	PENSTE
Penstemon virgatus	PEVI
Phacelia magellanica	PHMA
Phlox spp.	PHLOX
Phlox nana	PHNA
Polygala alba	POAL
Polygonum spp.	POLYGO
Potentilla spp.	POTEN
Potentilla crinita	POCR
Potentilla thurberi	POTH
Polemonium delicatum	PODE
Polemonium foliosissimum	POFO
Pseudocymopterus montanus	PSMO
Psoralea tenuiflora	PSTE
Ptelea trifoliata	PTTR
Pteridium aquilinum	PTAQ
Pyrola secunda	PYSE
Ranunculus inamoenus	RAIN
Rudbeckia laciniata	RULA
Senecio spp.	SENECI
Senecio actinella	SEAC
Senecio arizonicus	SEAR
Senecio bigelovii	SEBI
Senecio cardamine	SECA
Senecio eremophilus	SEER
Senecio hartianus	SEHA
Senecio lemmoni	SELE
Senecio multilobatus	SEMU
Senecio neomexicanus	SENE
Senecio sanguisorbioides	SESA
Senecio sacramentanus	SESC
Senecio spartioides	SESP
Senecio wootonii	SEWO
Silene laciniata	SILA
Silene scouleri	SISC
Sisymbrium spp.	SISY

Appendix 5 cont.

Sisyrinchium albidum	SIAL
Smilacina racemosa	SMRA
Smilacina stellata	SMST
Solidago spp.	SOLIDA
Stellaria jamesiana	STJA
Stellaria longifolia	STLO1
Swertia radiata	SWRA
Taraxacum laevigatum	TALA
Taraxacum officinale	TAOF
Thalictrum fendleri	THFE
Thermopsis montanum	THPI
Thlaspi montanum	THMO
Townsendia exscapa	TOEX
Trifolium dubium	TRDU
Urtica serra	URSE
Valeriana spp.	VALERI
Valeriana capitata	VACA
Valeriana edulis	VAED
Verbascum thapsus	VETH
Vicia spp.	VICIA
Vicia americana	VIAM
Viola spp.	VIOLA
Viola canadensis	VICA

Appendix C: Climax and Successional Status of Major Tree Species Within Habitat Types of the Lincoln National Forest*

C = Major Climax, Mc = Minor Climax, S = Major Seral, Ms = Minor Seral
A = Accidental, O = No Occurrence

	Species								
	ABLA	PIEN	PIPU	ABCO	PSME	PIST	PIPO	PIED	JUDE
Habitat Types									
ABCO-PSME ACGR	O	O	O	C	Mc	Mc	A	O	O
ABCO-PSME ACGR/HODU	O	O	O	C	Mc	Mc	A	O	O
ABCO-PSME ACGL/HODU	O	O	O	C	Mc	Mc	A	O	O
ABCO-PSME QUGA/HODU	O	O	O	C	Mc	Mc	Ms	O	O
PSME QUGA/HODU	O	O	O	O	C	Mc	S	Ms	A
ABCO-PSME QUGA	O	O	O	C	Mc	Mc	S	A	O
ABCO-PSME QUGA/MUVI	O	O	O	C	Mc	Mc	S	A	O
ABCO-PSME QUGA/MUDU	O	O	O	C	Mc	Mc	Ms	A	A
ABCO/JUMA	O	O	O	C	S	O	S	A	A
PSME/QUGA	O	O	O	O	C	Mc	S	Ms	A
PIPO/QUGA QUGA	O	O	O	O	O	O	C	Mc	Ms
PIPO/MUDU	O	O	O	O	O	O	C	Mc	Mc
PIPO/QUUN MUDU	O	O	O	O	O	O	C	Mc	Mc
PIPO/QUUN MUJO	O	O	O	O	O	O	C	Mc	Mc

*Includes only those habitat types developed by this study.

Appendix C: Cont.

	Species								
	ABLA	PIEN	PIPU	ABCO	PSME	PIPT	PIPO	PIED	JUDE
Habitat Types									
PIPU-PSME FROV	O	Mc	C	Mc	C	S	S	O	O
PIPU-PSME FROV/SECA	O	O	C	Mc	C	S	O	O	O
PIPU-PSME VAAC	O	O	C	Mc	C	S	S	O	O

Appendix D: Average Density and Frequency of Tree Species by Habitat Types

F = Frequency (Percentage of plots of habitat type species occurs in)
D = Average Density (Total number of trees divided by number of plots species was found in)

Species	Habitat Types: PIPU-PSME FROV (N=3)		PIPU-PSME FROV/SECA (N=1)		PIPU-PSME VAAC (N=1)		ABCO-PSME ACGR (N=3)		ABCO-PSME ACGR/HODU (N=3)	
	F	D	F	D	F	D	F	D	F	D
ABCO Yng Regen	67	11.0	100	7.0	100	11.0	100	46.0	100	8.7
ABCO Adv Regen	67	7.0	100	3.0	100	1.0	100	9.3	100	14.0
ABCO Mature	67	2.0	100	1.0	100	2.0	67	3.5	67	1.5
PIEN Yng Regen	33	2.0	0	0.0	0	0.0	0	0.0	0	0.0
PIEN Adv Regen	67	2.5	0	0.0	0	0.0	0	0.0	0	0.0
PIEN Mature	67	2.0	0	0.0	0	0.0	0	0.0	0	0.0
PIPU Yng Regen	67	3.5	100	1.0	0	0.0	0	0.0	0	0.0
PIPU Avd Regen	100	5.0	100	1.0	0	0.0	0	0.0	0	0.0
PIPU Mature	100	4.0	100	5.0	100	6.0	0	0.0	0	0.0
PIPO Yng Regen	33	1.0	0	0.0	0	0.0	0	0.0	100	5.3
PIPO Adv Regen	0	0.0	0	0.0	0	0.0	0	0.0	67	10.5
PIPO Mature	33	1.0	0	0.0	0	0.0	0	0.0	67	2.5
PIST Yng Regen	0	0.0	0	0.0	100	3.0	67	3.5	100	4.6
PIST Adv Regen	33	2.0	100	1.0	100	5.0	33	1.0	67	2.0
PIST Mature	0	0.0	0	0.0	0	0.0	67	3.5	33	4.0
POTR Yng Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
POTR Avd Regen	0	0.0	0	0.0	100	1.0	0	0.0	0	0.0
POTR Mature	33	1.0	0	0.0	100	3.0	0	0.0	0	0.0
PSME Yng Regen	67	7.5	0	0.0	100	7.0	100	7.3	100	6.0
PSME Adv Regen	100	4.7	0	0.0	100	32.0	100	4.3	67	8.5
PSME Mature	100	2.3	100	4.0	100	2.0	100	2.7	33	2.0
PIED Yng Regen	0	0.0	0	0.0	0	0.0	0	0.0	33	5.0
PIED Adv Regen	0	0.0	0	0.0	0	0.0	0	0.0	33	1.0
PIED Mature	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
JUDE Yng Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
JUDE Avd Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
JUDE Mature	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Yng Regen = Trees less than 2 inch DBH
Adv Regen = Trees 2 to 10 inch DBH
Mature = Trees greater than 10 inch DBH

Appendix D: Cont.

Species	Habitat Types: ABCO-PSME ACGL/HODU (N=6)		ABCO-PSME QUGA (N=8)		ABCO-PSME QUGA/HODU (N=5)		ABCO-PSME QUGA/MUVI (N=1)		ABCO-PSME QUGA/MUDU (N=2)	
	F	D	F	D	F	D	F	D	F	D
ABCO Yng Regen	50	5.7	75	5.0	100	8.0	100	1.0	100	3.5
ABCO Adv Regen	100	5.2	87	5.4	100	8.2	0	0.0	100	6.0
ABCO Mature	100	5.8	25	3.0	80	3.5	0	0.0	50	1.0
PIEN Yng Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIEN Adv Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIEN Mature	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIPU Yng Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIPU Adv Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIPU Mature	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIPO Yng Regen	0	0.0	37	9.0	60	2.0	100	1.0	100	4.5
PIPO Adv Regen	0	0.0	63	12.6	40	2.5	100	3.0	100	8.0
PIPO Mature	0	0.0	87	4.1	40	1.0	100	9.0	50	7.0
PIST Yng Regen	83	2.5	36	3.7	100	14.6	100	3.0	50	9.0
PIST Adv Regen	67	2.8	36	3.0	80	10.5	0	0.0	50	8.0
PIST Mature	50	2.0	12	3.0	20	6.0	0	0.0	50	4.0
POTR Yng Regen	16	1.0	0	0.0	20	7.0	0	0.0	0	0.0
POTR Adv Regen	33	1.0	0	0.0	20	1.0	0	0.0	0	0.0
POTR Mature	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PSME Yng Regen	100	3.2	100	12.5	100	26.8	100	7.0	100	17.0
PSME Adv Regen	100	5.8	75	7.3	100	8.0	100	2.0	100	13.0
PSME Mature	100	3.8	75	5.0	40	5.0	0	0.0	50	2.0
PIED Yng Regen	0	0.0	50	3.0	20	2.0	100	1.0	50	2.0
PIED Adv Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIED Mature	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
JUDE Yng Regen	0	0.0	38	1.6	0	0.0	100	1.0	50	1.0
JUDE Adv Regen	0	0.0	12	2.0	0	0.0	0	0.0	50	1.0
JUDE Mature	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Yng Regen = Trees less than 2 inch DBH
Adv Regen = Trees 2 to 10 inch DBH
Mature = Trees greater than 10 inch DBH

Appendix D: Cont.

Species	Habitat Types: PIPO/QUUN MUDU (N=6)		PIPO/QUUH MULO (N=2)	
	F	D	F	D
ABCO Yng Regen	0	0.0	0	0.0
ABCO Adv Regen	0	0.0	0	0.0
ABCO Mature	0	0.0	0	0.0
PIEN Yng Regen	0	0.0	0	0.0
PIEN Adv Regen	0	0.0	0	0.0
PIEN Mature	0	0.0	0	0.0
PIPU Yng Regen	0	0.0	0	0.0
PIPU Adv Regen	0	0.0	0	0.0
PIPU Mature	0	0.0	0	0.0
PIPO Yng Regen	100	13.3	50	3.0
PIPO Adv Regen	100	6.0	100	24.0
PIPO Mature	100	3.8	100	5.5
PIST Yng Regen	0	0.0	0	0.0
PIST Adv Regen	0	0.0	0	0.0
PIST Mature	0	0.0	0	0.0
POTR Yng Regen	0	0.0	0	0.0
POTR Adv Regen	0	0.0	0	0.0
POTR Mature	0	0.0	0	0.0
PSME Yng Regen	50	2.6	0	0.0
PSME Adv Regen	50	2.0	0	0.0
PSME Mature	33	1.5	0	0.0
PIED Yng Regen	100	20.6	100	7.0
PIED Adv Regen	100	4.8	50	6.0
PIED Mature	0	0.0	0	0.0
JUDE Yng Regen	83	8.4	100	7.0
JUDE Adv Regen	83	6.8	100	6.5
JUDE Mature	50	1.7	0	0.0

Yng Regen = Trees less than 2 inch DBH
Adv Regen = Trees 2 to 10 inch DBH
Mature = Trees greater than 10 inch DBH

Appendix D: Cont.

Species	Habitat Types: ABCO-JUMA (N=4)		PSME QUGA (N=9)		PSME/QUGA HODU (N=6)		PIPO/QUGA QUGA (N=2)		PIPO/MUDU (N=3)	
	F	D	F	D	F	D	F	D	F	D
ABCO Yng Regen	75	15.6	0	0.0	17	1.0	0	0.0	0	0.0
ABCO Adv Regen	75	6.0	0	0.0	0	0.0	0	0.0	0	0.0
ABCO Mature	75	6.3	0	0.0	0	0.0	0	0.0	0	0.0
PIEN Yng Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIEN Adv Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIEN Mature	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIPU Yng Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIPU Adv Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIPU Mature	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIPO Yng Regen	50	17.0	67	7.6	17	3.0	100	2.0	100	12.0
PIPO Adv Regen	75	5.0	89	11.3	67	4.5	50	24.0	100	20.0
PIPO Mature	50	2.5	67	2.0	50	2.7	50	4.0	100	3.3
PIST Yng Regen	0	0.0	89	14.4	100	15.6	0	0.0	0	0.0
PIST Adv Regen	0	0.0	89	6.9	100	5.8	0	0.0	0	0.0
PIST Mature	0	0.0	44	1.3	83	3.0	0	0.0	0	0.0
POTR Yng Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
POTR Adv Regen	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
POTR Mature	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PSME Yng Regen	20	3.0	100	24.9	100	14.5	0	0.0	33	6.0
PSME Adv Regen	0	0.0	100	8.4	100	14.6	0	0.0	33	7.0
PSME Mature	0	0.0	89	3.9	83	1.8	0	0.0	0	0.0
PIED Yng Regen	20	28.0	67	29.2	50	6.0	100	22.5	100	5.0
PIED Adv Regen	0	0.0	33	1.3	0	0.0	100	10.0	67	1.0
PIED Mature	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
JUDE Yng Regen	20	3.0	33	1.3	17	1.0	50	4.0	100	16.3
Jude Adv Regen	20	1.0	0	0.0	17	1.0	50	4.0	100	5.3
JUDE Mature	0	0.0	11	2.0	0	0.0	0	0.0	33	2.0

Yng Regen = Trees less than 2 inch DBH
Adv Regen = Trees 2 to 10 inch DBH
Mature = Trees greater than 10 inch DBH

Appendix E: Average Cover and Frequency of Major Species by Habitat Types

F = Frequency (Percentage of plots of habitat type species occurs in)
C = Average Cover (Total cover sampled divided by number of stands species was found in)

Species	PIPU-PSME FROV (N=3)		PIPU-PSME FROV/SECA (N=1)		PIPU-PSME VAAC (N=1)		ABCO-PSME ACGR (N=3)		ABCO-PSME ACGR/HODU (N=3)	
	F	C	F	C	F	C	F	C	F	C
Shrubs										
ACGL	67	2.3	100	1.0	0	0.0	0	0.0	0	0.0
ACGR	0	0.0	0	0.0	0	0.0	100	4.0	100	22.0
ACNE	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
CEMO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
FRPE	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
HODU	67	3.3	100	9.0	100	3.0	67	7.5	100	1.8
JUMA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
POAN	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
QUGA	67	1.8	100	T	100	1.0	100	1.3	50	1.0
QUGR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
QUUN	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
RHTR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
SYOR	0	0.0	0	0.0	100	T	0	0.0	33	T
VIAR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Graminoids										
ARAR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
BOCU	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
BOGR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
BRRI	100	1.3	0	0.0	100	T	100	1.8	100	T
CAREX	33	T	0	0.0	100	T	0	0.0	100	T
CARO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
CAFO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
ELTR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
FEAR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
KOPY	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
LYPH	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
MUDU	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
MUEM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
MULO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
MUMO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
MUPA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
MUVI	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIFI	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
POFE	33	1.0	0	0.0	100	T	0	0.0	100	1.0
POPR	67	5.3	100	80.0	0	0.0	100	30.0	0	0.0
SCSC	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
SIHY	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
STPR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
TRMO	67	1.3	100	10.0	100	T	67	6.5	100	T

T = Trace occurrence in plot

Appendix E: Cont.

Species	Habitat Types: PIPU-PSME FROV (N=3)		PIPU-PSME FROV/SECA (N=1)		PIPU-PSME VAAC (N-1)		ABCO-PSME ACGR (N=3)		ABCO-PSME ACGR/HODU (N=3)	
	F	C	F	C	F	C	F	C	F	C
Forbs										
ARLU	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
CHALS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
CLLI	0	0.0	0	0.0	0	0.0	0	0.0	33	T
CYFR	67	T	100	5.0	100	1.0	67	T	67	1.0
DUHO	67	T	100	5.0	100	T	0	0.0	0	0.0
ERIGER	0	0.0	100	5.0	0	0.0	33	T	0	0.0
FRAM	0	0.0	0	0.0	0	0.0	0	0.0	33	T
FRBR	67	T	100	1.0	0	0.0	0	0.0	33	T
FROV	100	7.5	100	T	100	2.0	0	0.0	0	0.0
GAAS	100	7.5	0	0.0	100	2.0	0	0.0	0	0.0
GABO	0	0.0	100	1.0	0	0.0	100	T	67	T
GECA	100	T	0	0.0	0	0.0	0	0.0	0	0.0
GERI	67	T	100	10.0	0	0.0	33	T	0	0.0
HASP	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
IRMI	100	T	100	2.0	0	0.0	0	0.0	0	0.0
LAAR	33	T	100	T	100	T	67	T	0	0.0
LIMU	0	0.0	0	0.0	0	0.0	33	T	0	0.0
OXAL	100	1.0	0	0.0	100	T	67	T	0	0.0
PSMO	100	T	0	0.0	100	2.0	33	T	33	T
SESA	67	T	0	0.0	100	1.0	0	0.0	0	0.0
SMST	0	0.0	0	0.0	0	0.0	33	3.0	0	0.0
STIO1	0	0.0	0	0.0	100	T	0	0.0	0	0.0
THPE	67	T	0	0.0	0	0.0	0	0.0	67	T
VAAC	0	0.0	0	0.0	100	15.0	0	0.0	67	1.0

T = Trace occurrence in plot

Appendix E: Cont.

Species	Habitat Types: ABCO-PSME ACGL/HODU (N=6)		ABCO-PSME QUGA (N=8)		ABCO-PSME QUGA/HODU (N=5)		ABCO-PSME QUGA/MUVI (N=1)		ABCO-PSME QUGA/MUDU (N=2)	
	F	C	F	C	F	C	F	C	F	C
Shrubs										
ACGL	100	9.2	13	T	0	0.0	0	0.0	0	0.0
ACGR	0	0.0	13	T	0	0.0	0	0.0	0	0.0
ACNE	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
CEMO	0	0.0	33	1.5	0	0.0	0	0.0	0	0.0
FRPE	16	T	20	2.2	0	0.0	0	0.0	0	0.0
HODU	100	12.5	0	0.0	100	9.6	0	0.0	0	0.0
JUMA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
POAN	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
QUGA	100	1.8	100	18.4	100	7.6	100	T	100	11.0
QUGR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
QUUN	0	0.0	0	0.0	0	0.0	100	T	0	0.0
RHTR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
SYOR	33	1.5	33	1.0	60	2.3	0	0.0	0	0.0
VIAR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Graminoids										
ARAR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
BOCU	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
BOGR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
BRRI	83	2.4	80	3.1	80	2.0	100	2.0	50	1.0
CAREX	0	0.0	40	T	0	0.0	0	0.0	0	0.0
CARO	0	0.0	20	T	0	0.0	0	0.0	0	0.0
CAFO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
ELTR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
FEAR	0	0.0	40	1.1	0	0.0	0	0.0	0	0.0
KOPY	0	0.0	0	0.0	0	0.0	0	0.0	100	T
LYPH	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
MUDU	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
MUEM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
MULO	0	0.0	20	3.5	0	0.0	0	0.0	0	0.0
MUMO	0	0.0	10	1.0	20	1.0	0	0.0	0	0.0
MUPA	0	0.0	20	T	16	T	100	T	0	0.0
MUVI	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIFI	0	0.0	0	0.0	20	T	100	1.0	100	T
POFE	16	10.0	70	1.8	20	T	0	0.0	0	0.0
POPR	33	1.0	0	0.0	0	0.0	0	0.0	0	0.0
SCSC	0	0.0	0	0.0	0	0.0	100	2.0	50	2.0
STHY	0	0.0	60	T	0	0.0	0	0.0	50	2.0
STPR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
TRMO	16	T	0	0.0	0	0.0	0	0.0	0	0.0

T = Trace occurrence in plot

Appendix E: Cont.

Species	Habitat Types: ABCO-PSME ACGL/HODU (N=6)		ABCO-PSME QUGA (N=8)		ABCO-PSME QUGA/HODU (N=5)		ABCO-PSME QUGA/MUVI (N=1)		ABCO-PSME QUGA/MUDU (N=2)	
	F	C	F	C	F	C	F	C	F	C
Forbs										
ARLU	0	0.0	33	T	0	0.0	100	1.0	0	0.0
CHALS	33	T	0	0.0	60	T	0	0.0	0	0.0
CLLI	33	2.0	0	0.0	100	1.0	0	0.0	0	0.0
CYFR	83	1.3	20	T	100	1.0	0	0.0	0	0.0
DUHO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
ERIGER	16	T	40	T	40	T	0	0.0	0	0.0
FRAM	33	T	0	0.0	0	0.0	0	0.0	0	0.0
FRBR	33	1.0	20	T	20	1.0	0	0.0	0	0.0
FROV	0	0.0	100	T	40	T	0	0.0	0	0.0
GAAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
GABO	67	T	30	T	60	T	100	T	0	0.0
GECA	16	2.0	40	T	20	T	100	1.0	0	0.0
GERI	16	T	30	T	20	T	0	0.0	50	T
HASP	0	0.0	0	0.0	20	T	0	0.0	0	0.0
IRMI	16	3.0	0	0.0	0	0.0	100	T	0	0.0
LAAR	33	T	50	T	20	T	0	0.0	100	T
LIMU	0	0.0	20	T	20	T	0	0.0	0	0.0
OXAL	33	1.3	10	T	40	T	0	0.0	0	0.0
PSMO	50	T	30	T	50	T	0	0.0	0	0.0
SESA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
SMST	16	T	0	0.0	80	1.0	0	0.0	0	0.0
STLO1	67	T	10	12.0	60	T	0	0.0	0	0.0
THFE	100	1.3	70	3.3	80	1.0	100	1.0	0	0.0
VAAC	16	T	0	0.0	40	T	0	0.0	0	0.0

T = Trace occurrence in plot

Appendix E: Cont.

Species	Habitat Types: ABCO/JUMA (N=4)		PSME QUGA (N=9)		PSME/QUGA HODU (N=6)		PIPO/QUGA QUGA (N=2)		PIPO/MUDU (N=3)	
	F	C	F	C	F	C	F	C	F	C
Shrubs										
ACGL	0	0.0	0	0.0	20	T	0	0.0	0	0.0
ACGR	25	T	0	0.0	0	0.0	0	0.0	0	0.0
ACNE	100	8.0	0	0.0	0	0.0	0	0.0	0	0.0
CEMO	50	T	33	T	0	0.0	50	T	33	1.0
FRPE	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
HODU	0	0.0	0	0.0	100	3.0	0	0.0	0	0.0
JUMA	100	4.0	0	0.0	0	0.0	0	0.0	0	0.0
POAN	100	10.0	0	0.0	0	0.0	0	0.0	0	0.0
QUGA	75	3.0	100	1.4	100	21.3	100	9.5	33	1.0
QUGR	0	0.0	0	0.0	0	0.0	0	0.0	33	T
QUUN	0	0.0	20	3.5	0	0.0	0	0.0	67	4.0
RHTR	0	0.0	10	T	0	0.0	0	0.0	0	0.0
SYOR	0	0.0	0	0.0	33	2.5	0	0.0	0	0.0
VIAR	75	2.5	0	0.0	0	0.0	0	0.0	0	0.0
Graminoids										
ARAR	0	0.0	0	0.0	0	0.0	0	0.0	67	T
BOCU	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
BOGR	0	0.0	10	1.0	0	0.0	50	T	25	1.0
BRRI	25	T	80	1.0	100	1.7	100	T	25	1.0
Carex	25	T	30	T	23	T	100	T	67	T
CARO	25	1.0	0	0.0	0	0.0	0	0.0	0	0.0
CAFO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
ELTR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
FEAR	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
KOPY	25	T	33	1.8	0	0.0	100	1.5	25	1.0
LYPH	0	0.0	0	0.0	0	0.0	0	0.0	33	T
MUDU	0	0.0	10	T	0	0.0	0	0.0	100	3.6
MUEM	0	0.0	0	0.0	0	0.0	0	0.0	33	2.0
MULO	0	0.0	10	1.0	0	0.0	0	0.0	0	0.0
MUMO	25	T	10	2.0	0	0.0	50	1.0	0	0.0
MUPA	0	0.0	40	1.3	0	0.0	0	0.0	0	0.0
MUVI	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
PIFI	25	1.0	0	0.0	0	0.0	0	0.0	75	T
POFE	50	1.0	73	1.2	20	T	100	1.0	0	0.0
POPR	25	10.0	0	0.0	20	T	0	0.0	0	0.0
SCSC	0	0.0	10	4.0	0	0.0	50	1.0	67	T
SIHY	50	3.3	72	1.0	0	0.0	100	2.0	25	1.0
STPR	0	0.0	40	3.5	60	2.0	0	0.0	30	1.0
TRMO	0	0.0	10	T	20	T	0	0.0	0	0.0

T = Trace occurrence in plot

Appendix E: Cont.

Species	Habitat Types: ABCO/JUMA (N=4)		PSME QUGA (N=9)		PSME/ UGA HODI (N=6)		PIPO/QUGA QUGA (N=2)		PIPO/MUMU (N=3)	
	F	C	F	C	F	C	F	C	F	C
Forbs										
ARLU	0	0.0	33	T	16	T	100	T	33	T
CHALS	0	0.0	40	T	60	1.0	0	0.0	0	0.0
CLLI	0	0.0	0	0.0	40	T	0	0.0	33	T
CYFR	0	0.0	0	0.0	40	T	0	0.0	25	T
DUHO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
ERIGER	50	T	0	0.0	20	T	0	0.0	0	0.0
FRAM	0	0.0	10	T	0	0.0	0	0.0	0	0.0
FRBR	0	0.0	0	0.0	40	T	0	0.0	0	0.0
FROV	25	T	30	T	20	T	0	0.0	0	0.0
GAAS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
GABO	25	T	70	T	60	T	50	T	0	0.0
GECA	50	1.0	64	T	100	T	100	T	0	0.0
GERI	50	T	30	T	20	T	0	0.0	0	0.0
HASP	0	0.0	11	T	0	0.0	0	0.0	100	T
IRMI	0	0.0	11	T	0	0.0	0	0.0	0	0.0
LAAR	25	T	64	T	60	T	100	T	0	0.0
LIMU	25	T	54	T	20	T	100	1.0	50	T
OXAL	75	T	18	T	20	T	0	0.0	0	0.0
PSMO	0	0.0	54	T	100	T	0	0.0	16	T
SESA	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
SMST	25	T	0	0.0	40	1.0	0	0.0	0	0.0
STLO1	0	0.0	18	T	60	T	0	0.0	0	0.0
THFE	100	1.4	27	T	60	T	50	T	0	0.0
VAAC	25	T	11	1.0	20	T	0	0.0	0	0.0

T = Trace occurrence in plot

Appendix E: Cont.

Species	Habitat Types: PIPO/QUUN MUDU (N=6)		PIPO/QUUN MULO (N=2)	
	F	C	F	C
Shrubs				
ACGL	0	0.0	0	0.0
ACGR	0	0.0	0	0.0
ACNE	0	0.0	0	0.0
CEMO	14	T	0	0.0
FRPE	0	0.0	0	0.0
HODU	0	0.0	0	0.0
JUMA	0	0.0	0	0.0
POAN	0	0.0	0	0.0
QUGA	28	4.0	0	0.0
QUGR	50	12.3	0	0.0
QUUN	57	20.0	100	13.0
RHTR	43	T	50	T
SYOR	0	0.0	0	0.0
VIAR	0	0.0	0	0.0
Graminoids				
ARAR	14	T	50	1.0
BOCU	28	1.3	50	1.0
BOGR	43	1.0	100	2.5
BRRI	50	T	0	0.0
CAREX	33	1.0	0	0.0
CARO	0	0.0	0	0.0
CAFO	0	0.0	0	0.0
ELTR	0	0.0	0	0.0
FEAR	0	0.0	0	0.0
KOPY	33	1.0	50	2.0
LYPH	16	T	0	0.0
MUDU	83	7.4	0	0.0
MUEM	16	T	0	0.0
MULO	0	0.0	100	15.0
MUMO	43	T	0	0.0
MUPA	33	T	0	0.0
MUVI	0	0.0	0	0.0
PIFI	16	2.0	0	0.0
POFE	67	3.9	0	0.0
POPR	16	T	0	0.0
SCSC	67	T	0	0.0
SIHY	33	1.0	100	T
STPR	16	4.0	0	0.0
TRMO	0	0.0	0	0.0

T = Trace occurrence in plot

Appendix E: Cont.

Species	Habitat Types: PIPO/QUUN MUDU (N=6)		PIPO/QUUN MULO (N=2)	
	F	C	F	C
Forbs				
ARLU	83	T	0	0.0
CHALS	0	0.0	0	0.0
CLLI	0	0.0	0	0.0
CYFR	0	0.0	0	0.0
DUHO	0	0.0	0	0.0
ERIGER	16	T	0	0.0
FRAM	0	0.0	0	0.0
FRBR	0	0.0	100	T
FROV	0	0.0	0	0.0
GAAS	0	0.0	0	0.0
GABO	16	T	50	T
GECA	33	T	0	0.0
GERI	0	0.0	0	0.0
HASP	0	0.0	0	0.0
IRMI	16	T	0	0.0
LAAR	0	0.0	0	0.0
LIMU	60	T	50	T
OXAL	0	0.0	0	0.0
PSMO	0	0.0	0	0.0
SESA	0	0.0	0	0.0
SMST	0	0.0	0	0.0
STLO1	0	0.0	0	0.0
THFE	16	T	0	0.0
VAAC	0	0.0	0	0.0

T = Trace occurrence in plot